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JOURNEY INTO WONDER

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JOURNEY INTO WONDER

by

N. J. BERRILL

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1953

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To
Jacquelyn
Who has come every step of the way
and to my children
who I hope
will one day take the journey
into wonder

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I

STARS OVER EDEN

I

JOURNEY INTO WONDER

It is five centuries since Columbus first saw the light of day. Many years later he saw another light, and with the coming of the dawn found the threshold to paradise. So he thought, and so ended the night: a long night of waiting to see what the rising sun might bring. In another way the voyage of Columbus was itself a dawning, for it ended the long night of a thousand years, the Dark Ages when Europe was in the womb.

In the fifteenth century men were looking west into the path of the setting sun for the first time since the Phoenicians sailed past the Pillars of Hercules. The Portuguese had discovered the Canary Islands early in the same century and the Azores possibly in the year of Columbus' birth. The medieval world was shaking itself awake from its distorted dreams, opening its eyes to a wider horizon, and Columbus grew up at a time when talk was rife with rumours of strange and distant lands, of monsters, and of gold. He listened and thought, hearing both the siren-call of sails to the west and the fantastic legends and beliefs of a credulous past already close on two thousand years old. So three ships went sailing west to find a new world and to see it through the eyes of a dreamer.

Here lies our tale, of space and time, of new wine in old bottles, of men going down to the sea in ships, sailing westward round the world for five hundred years. Our modern world, for better or worse, was born in the fifteenth century, and ever since, generation after generation, young men have gone west. With each setting forth, a new unsullied mind has seen the world in a fresher light than the last, has been called by adventure and returned in wonder.

Each voyager has been a naturalist, for one reason or another, and it is as a naturalist that I can see through their eyes the changing world that they record, change which in part has come from the impact of the voyages themselves and partly from the changing minds of the successive observers. As a naturalist concerned with the sea and the land and the planets as abodes of life, I find my own beginnings early in this story. The living universe which I and my generation see in this, our time, is something that has grown from a tale of high adventure, and this book is written for the enjoyment of reliving the gradual discovery of a new world.

Columbus and the Portuguese were naturalists by compulsion. Their navigational aids were so crude and poorly understood that all signs were significant, and for signs they watched. When the captains of Elizabeth followed the Spaniards, the world was already changing, and for the first time men looked upon the life they saw for its own interest rather than as a symbol of something else.

The Queen's commissions gave way to letters of marque and to outright buccaneering of the seventeenth century. And perhaps the most amazing naturalist of all time was a pirate, William Dampier, who in belated respectability piloted the ships that rescued Robinson Crusoe.

Commissioned or not, their world was but half awake; what they saw was seen in fascination and wonder of a kind, for the world we know had not yet displaced the old. Not before the passing of another century, which is less time than it sounds, did ships sail west around a planet no longer the centre of a universe. Only then, in the half-dozen years before the Declaration of Independence, did Captain Cook set sail, with chronometers and astronomers on board for the first time, not with the wealth of the Indies or the gold of Spain in mind, but to observe the transit of Venus.

The course is the same as before—west, and south round South America and across the Pacific—but this time the world is new, the mind is fully awake and wide in wonder. Young men follow in quick succession: von Humboldt, Charles Darwin, and others in ever-increasing numbers. The southern continent is first sketched in, then penetrated, and gradually the land is known from the mouths of the rivers to the Andes heights. The world shrinks, gets too well explored, yet still the wonder grows. Humboldt went up the rivers and climbed the ranges, saw both the wealth of life and suggestions of a past. Darwin followed him, but farther south where the sea once covered the land. He saw more perhaps of the dead than of the living, and the past grew dominant in his mind. Time then became the fourth dimension and the world took shape in another way. The new land, filled with strange life, has had a changing history, and its unravelling becomes our own part of the journey. There is a saying that no man crosses the same river twice, the river will have changed a little, the man perhaps a lot, and now we see, a century later, an American past of many million years. We journey into time, and the surge of life sweeping into and out of the American continents through the ages I believe is as dramatic a play as this planet has ever staged. When the curtain falls we find that we have joined the players, and time goes forward as well as back.

This is a tale of men who have made discoveries. It is even more a tale of dawning recognition and deciphering of the earthly past, a tale cut short as the past becomes the present. The human problem is at root the need to know what we are doing here on this planet, and each new generation finds the problem fresh. Columbus showed to Europe that America existed, and men thereafter could see a half of the world objectively. This has been important, for you need detachment to see a thing clearly. And gradually, progressively, each succeeding century has gained a clearer vision. The story starts slowly, for at first the men are muddled and the things they see are strange, but this is the reality of it, understanding is itself a growth, and it comes from individual men. And so to me the men, their times, their thoughts, and their lives are one, and there is more meaning for me and I hope for you in tracing the development of the man and his mind through these five centuries. It begins in Spain on a quiet summer night—

"Lord Princes, I resolved to describe each night what passed in the day, and to note each day how I navigated at night, for I shall forget sleep!" So wrote Columbus in his journal. He dated it August 2, 1492, and the dark scented night closed in upon the three small heavy-laden ships waiting on the river at Palos. The grey dawn found them gone, heading for the bar of Saltes and the wind-whipped waters of the Bay of Cadiz.

All day they sailed south from Spain with a strong sea-breeze, until sunset, when they set a more westerly course toward the Canaries. Columbus had his dreams, and from them drew his strength. But he did not share them, and other men were afraid.

Note the course, south and west to the Canaries and then off into uncharted seas, for the course stays the same as the centuries roll by and other mariners journey farther and farther into new realms of wonder. The purpose changes with each new voyage and is almost beside the point, for each time it is the journey itself that matters, not the reason for starting. There are many ways of lighting a fire, but only the blaze is important. And so each man in his turn sees more of the world, and broods upon what he sees; each contributes to the unfolding knowledge of living things. There was no hurry, now or later; until the last great days of the racing clippers a ship set sail to return only in God's good time and often not at all.

After a month among the islands the real vôyage began. Like a starter pulling his gun, the volcanic Peak of Teneriffe blew its top and a great flame shot into the sky, and reluctant sailors let go of their last terrestrial tie to the known world. The wind blew and soon a part of a mast from a large ship drifted by.

The signs were commencing, some bad, some good, some mysterious and alarming, and none of them understood for what they really were. "A marvellous flame of fire fell from heaven into the sea"—meteors, perhaps—and the following day "those of the caravel *Niña* reported that they had seen a tern and a boatswain bird, and these birds never go more than twenty-five leagues from land". I have seen them too, and while they are beautiful, the phrase certainly does not mean that the hard-bitten sailors on the *Niña* had any great interest in birds as birds. But they knew well, as did every man in the expedition, that the Portuguese had discovered the Atlantic Islands of the Canaries, the Azores, and the Cape Verde by noting the direction of flight of birds at sea. They had to know which birds rested or slept on the water and which only on land, and how far from land they could roam. Every traveller looks for signs, and I have watched for birds myself to show the way to an island lost in fog no more than a mile from the shore. So we find here a conclusion, based on the presence of the boatswain bird in particular since it was the more precisely identified, that there was land, probably an island, somewhere within one hundred miles. The bird was a sign, but was it a true sign?

Now all four voyages of Columbus have become fairly well charted, and when the bird was first seen no land was any closer than the Azores, six hundred miles to the north. Yet the reasoning was logical; the birds were known to keep within a certain distance of land, and it seemed simple enough. We all do it. We draw conclusions from a few facts, not realizing that we usually have but half the story.

The boatswain bird got its name from its short, piercing whistle, as though a ship's bosun were piping all hands on deck. I know it better as the tropic bird and never cease to wonder at its grace. The Portuguese were familiar with it because it breeds in the Cape Verde Islands, and its habits during the breeding season led them to the belief that it never flew far from land. Tropic birds, among the most beautiful in creation, nest in natural rock cavities in the cliffs and rocks of the Atlantic Isles. Naturally they stay fairly close until their offspring are able to feed themselves. I have seen them set forth to their feeding grounds at daybreak, returning from the first trip about eight o'clock in the morning with breakfast for the babies. With their catch of squid or fish they fly toward the rocky entrance to the nest, though they may swing back and forth sometimes for an hour before actually alighting. It is a difficult performance to fly directly into the hole and reach the nest, and you wonder why they don't break their wings or neck—for these birds are so completely adapted to an ocean life that they can neither walk nor stand up. When they wish to leave the nest, they rest with their breasts on the ground, use their wings as props, and push along on their bellies. Then they sail away, and can reach feeding grounds a hundred miles away and still get back before dusk.

What the admiral and his captains did not know was that tropic birds merely tolerate land for the brief two months it takes to raise their families. For the rest of the year they roam the tropical seas as far from land as it is possible to get and take the ocean for their own. No one who has ever crossed the Atlantic Ocean between Cancer and Capricorn can forget the sudden visit and shrill whistle of the boatswain bird in tropical waters where birds are scarce, a white, gleaming, long-tailed creature passing high on rapidly beating wings and streaking away like an animated comet. Scientists have well named it after Phaeton, the son of Apollo, who hurtled from the far sky into the sea. A sign of land or not, no symbol could have better graced that first voyage into the unknown ocean.

This was mid-September. The signs encountered during the next few days were equally uplifting and depressing. Navigation was carried on mainly in connection with nightly bearings on the North Star, by means of the astrolabe and the compass, and while they knew well enough that the magnetic needle did not point to the exact north, it was shocking to find the needles now pointing north-westerly, and fluctuating at that. It shook their sense of security in their already shaky capacity for navigation. The magnetic north was entirely unthought of, and Columbus had no idea that he had crossed the point of no variation. His world was strangely different from ours.

As if to quiet their fears fate gave further signs. Seaweed torn from a shore so recently that a hapless crab enmeshed in it was still alive, a boatswain bird, soft breezes, and water less salt than it had been; it is no wonder that "everyone was pleased, and the best sailors went ahead to sight the land first", all signs coming from the west!

Once again the sustaining signs were false and the ships had yet to reach the mid-Atlantic. But, like the variation of the compass, Columbus was seeing for the first time something unknown to Europeans, though the ancient Phoenicians—sailors who once sailed between the Pillars of Hercules, from the Mediterranean to Iceland, and ventured far out into the Tropical Ocean—may have seen it too. Columbus was entering the Sargasso Sea, a sea of floating weed in the middle of an ocean, a sea that became a legendary terror to seamen of later times. Great masses of weed sometimes cover the ocean as far as the eye can see, and strange rumours were to grow that ships became caught in it, finally to rot and sink. Legends and travellers' tales lived through the centuries, of a graveyard of ships, of the black heart of an ocean that drew ships and men to itself, to crush them or spew them forth, according to its fancy—of weed as dense as a bale of hay, with the grip of an octopus.

The reality is otherwise, though no less strange. The Sargasso weed, no matter how extensive it seems, hardly impedes the way of a ship, though lack of wind may enhance the illusion. But the weed is peculiar, for it lives and grows as a floating seaweed of the warm oceans, far from land or even shallow water. Its spiky growing tips and bladder buoys give it a distinctive appearance, as Columbus well noted. And it has so long drifted with the ocean currents that sea animals have changed and adapted themselves to a life among the weed as though it were a world in itself, all of them taking on the yellow-brown colours of the floating fronds. Not only are crabs to be found among it, but peculiar small fish called fishing frogs cling to it and are so well camouflaged by colour and shape that they are practically invisible. And we must add certain small snails and worms not to be found elsewhere in the world.

Such is the weed and its living freight, but the sea of weed is also real. It is an enormous eddy of slowly turning water. The great sweep of the Gulf Stream to the north and east across the Atlantic, the Canaries current flowing south along the eastern side, and the driving North Equatorial current that flows from the bulge of Africa across to the West Indies, form the edge of a great spinning wheel of water occupying most of the North Atlantic Ocean. The centre of the wheel moves slowly and the Sargasso weed drifts into it and multiplies to form a floating sea of weed a thousand miles across.

Not only was the weed no sign of land, it was not even a sign of shallow water, for the sea floor lies almost four miles beneath its centre. Yet the sea has its mysteries, for the eels of of the ponds and streams of both Europe and North America make a voyage of no return through uncharted wastes of dark ocean, to spawn a mile or more below the surface of the Sargasso Sea, and then to die leaving their eggs to float upward and drift for one or two years back to their respective continents.

Ignorance is often bliss, and had Columbus and his men known the sign of the weed and the crab for what it was, their hearts might have failed them. As it was, the weed increased as the ships sailed west and other signs no less false came to keep their courage high. Ten days and four hundred leagues from the Canaries they saw boobies and a whale, ran into smooth seas and a drizzling rain, weather that was a sure sign of land, a whale that always keeps close to shore, boobies which "sleep on shore, and go to sea in the mornings in search of food, not extending their flight more than twenty leagues from the land". And to cap it all they saw sandpipers and a dove. Land must be near, and at sunset on September 25 all thought they could see it in the far distance. Columbus knelt and gave thanks to the Lord.

Where were they? In mid-Atlantic, as far from their landfall as from their point of departure, about fifteen hundred miles from the West Indies, from South America, from Newfoundland, or back to the Canaries. Anything that upheld their faith at this time was all to the good. Or perhaps their optimism was wishful thinking. For whales had been seen only close to shore because men had not gone far enough away to find them elsewhere. Boobies, large sea-birds like the gannets of northern seas, had been seen only in nesting colonies on islands, when they naturally stay close to the young they have to feed. And the sailors did not know the sandpipers as the phalaropes that sweep across the ocean, nor that the dove was a noddy tern, a sea-bird with the size and plump greyness of a dove, that ranges through the tropical Atlantic.

Hope deferred left boredom in its wake, and at least the sight of boobies must have relieved the monotony of incessant sailing into a boundless ocean. The mariners knew them well, for, like the tropic birds, the brown boobies include the Cape Verde Islands among their nesting-places. But also like the tropic birds they wander far from land when family duties are over, high-sailing birds with a six-foot wing-spread. What held the interest of the men on the *Santa Maria* and the two caravels was their proficiency at fishing. Boobies are called boobies from the clumsy way they stumble about on the ground, suggesting stupidity, but the awkwardness is merely the penalty paid for sheer mastery of air and water. On shore they will assemble in bands in the teeth of a gale and dive for fish just beyond the breakers. But over blue water, where they belong, they dive from masthead heights or higher, suddenly pitching downward and flying fast until about fifteen feet from the water. Then the wings close and the birds enter the water like aerial torpedoes, with such force as to form a curve of thirty or forty yards before coming to the surface again. The white birds reported with the boobies in the journal may have been the white masked booby, wandering into the Sargasso Sea from the west, but not recognized since it does not breed as far east as the Portuguese Islands. It is a soaring bird that can take advantage of the wind spilled up by the bow of a ship; and underwater, I have seen it use its black tail fanned out as a rudder.

How deep boobies can dive is uncertain. All life is inherently lazy and works under compulsion of some sort or other, and diving birds dive for fish, not for fun, the shallower the better. Only penguins perhaps are so at home in their watery element that they seem to abandon themselves to the pure joy of motion, like gulls circling high in the up-draft of some towering headland, and only when performance is perfect do birds, beasts, and human beings seem to get enough satisfaction to compensate fully for the effort. The most polished of the divers is probably the blue-footed booby, which can dive from fifty feet into less than two feet of water, and in deeper water enters without even a splash. Most of what we know of the boobies concerns the related northern gannets. I have seen them in the Gulf of St. Lawrence, and in the western approaches to the British Isles, and always there is a superb mastery of wind and water that takes your breath. And my first impression is still the most vivid, of great white birds flashing down from a sullen sky into the inky blue-black waters of a stormy Firth of Clyde, dropping vertically one after another as deep-swimming fish caught their eyes. Sight is everything, and sounds and smells mean little to them. You can tell how deep the fish are by the angle of the dive. Sloping dives mean that the fish are shallow, high vertical ones when they are deep—and fishermen have caught them in nets set eighty feet below the surface.

The land so thankfully seen became only clouds on the horizon. Yet hope persisted, for the sea was as smooth as a river, so smooth that many sailors bathed alongside the ships. They saw a good many dorados, or dolphin fish, not to be confused with the true dolphin, which is a warm-blooded sea mammal, but a voracious, high-headed fish weighing as much as sixty pounds and often six feet long. The dorado is as oceanic as the tropic bird and one of the fastest swimmers in the sea. The bathers must have taken some pleasure in its shimmering colours, even if the quarters may have been a little close, for they are a brilliant green or blue above, shading to silvery white below, with purple and golden reflections, and bright blue spots on the head and back. Some of the fish were caught, and the sudden fading of the colours as the fish died on deck struck silent for a moment even the common sailors.

The dolphins stayed with the ship for several days, and while flying fish are not mentioned in the journal until somewhat later, there is little doubt they were all about, for the two go together. Flying fish are recorded only once during the voyage, about a week later, and then apparently because large numbers actually landed on deck. Maybe it was just as well that most sailors were already familiar with them in the seas south of Portugal, for otherwise fish that could fly might have been taken for a sign of heaven, let alone a new earth.

When the first true sign of land really did come, it was so mixed up with the false that it had no unusual import. On the 29th day of September frigates, or man-of-war birds, sailed overhead, and in this case the account is almost correct. The bird "makes the boobies vomit what they have swallowed, and eats it, maintaining itself on nothing else. It is a seabird, but does not sleep on the sea, and does not go more than twenty leagues from the land. There are many of them at the Cape Verde Islands."

These birds are definitely not ocean wanderers like their dainty relatives the tropic birds, and they usually cling closely to their island homes. The full name is "magnificent man-of-war bird", and both names indicate its nature as a bird of prey. Throughout the Caribbean, from Trinidad to the Isthmus, they are everywhere in evidence, not only over the ocean but often soaring with the black vultures over the hot plains of the mainland. On the white sands of the Dry Tortugas I have lain in the shade of the casuarinas, when I should have been studying the marine zoology I was there for, watching them sail back and forth across the sky in black and sinuous silhouette. Their wings are proportionately longer than those of any other bird, even of the wandering albatross.

and their great chest-muscles make up a quarter of the whole body. Yet despite, or perhaps because of, this equipment the man-of-war can only take flight readily from a bush or the edge of a cliff, and never rests upon the water. But it can fly through gale and hurricane and can make much longer sorties from land than the twenty leagues of Columbus. When he first saw them, according to all but the most recent charting of his course, the nearest land was Puerto Rico, some seven hundred miles to the south.

Man-of-wars have been seen to swoop upon an ascending booby, seize it by the legs, and turn it head over heels in mid-air, a sure way to make it disgorge its fish. Yet probably they get the bulk of their food by their own efforts, plunging toward the sea from great heights, with a sound like the hiss of an arrow shot into water, and then without wetting feathers or feet, rising and tossing up the prey before swallowing it. In fact, the skittering flying fish are literally caught between the devil and the deep blue sea.

And so for another week, boobies and frigates, dorados and flying fish, and the weed, marked the track of the three small ships. "The sea was smooth and quiet." The signs increased and the imminence of land appeared so certain that the *Niña*, the fastest of the three, pushed on ahead, hoping to sight it first.

Late the following night "the admiral, being on the castle of the poop, saw a light, though it was so uncertain that he could not affirm it was land . . . he saw the light once or twice, and it was like a candle rising and falling. It seemed to few to be an indication of land; but the admiral made certain land was close. At two hours after midnight the land was sighted at a distance of two leagues. They shortened sail and lay by under the mainsail without the bonnets. The vessels were hove to, waiting for daylight."

With the coming of the dawn the flat islands of Paradise stood before them, and they came to land.

2

LANDING LIGHTS

SUNRISE OPENED on a new world, and in more ways than one. Columbus thought his dreams were coming true, and he never fully understood what had happened. Others were to follow him, sharp-eyed materialists with an entirely different outlook, also lost in wonder, but with a wonder overlain by the arrogance of power. Three hundred years would pass before men richer in understanding, humbler in spirit, and without armour would enter and begin to know what lay before them. As it was, a mystical man with no sin greater than vanity drew back the curtain of time and space and exposed a hemisphere to the hungry eyes of Europe. What they saw was interpreted in terms of what they knew—land, labour, gold, trade, and, not least, pagans. And what Columbus saw was a small coral-girdled jewel in a sunlit sea, and had he been more himself and less the product of his times he would have remained enchanted. The glamour of that landfall has remained through the years, partly perhaps because it has never been finally identified.

The island of the landing was named San Salvador, the gentle Lucayans called it Guanahani. Which was it, of the many that stood in the path of the *Santa Maria?* For days Columbus had been sailing on a westerly course that trended to the south-west, and Watling's Island, lying like an outrider midway along the Atlantic bank of the Bahamas, is generally considered to be San Salvador. With the full weight of the Harvard–Columbus Expedition of 1939 behind the verdict, you would think that San Salvador would be pin-pointed on Watling's for ever, for that expedition faithfully followed the sailing directions as set down by Columbus in his journal.

Yet there had already been a serious challenge, or so it seems to me, for it was made by a fellow marine biologist. It concerns the light which rose and fell like a candle-flame, which was assumed to have been on land simply because no other explanation was forthcoming. The question has worried many people, for an unexplained mystery bothers a man like an unfinished sentence, and the simpler the facts the more we look for an answer. Suggestions that it was a light in a native canoe or merely a product of pure imagination are hardly credible, for the canoe would have been dangerously far out in the open Atlantic, while the record is too detailed and well confirmed to be one of hallucination, though the reports of flying saucers should make us pause. Suggestion is very powerful!

Land when it was sighted was seen by the light of the moon at a distance of about six miles, and at night the low-lying islands could hardly have been seen much farther away. The light had been seen four hours earlier when they were about forty miles distant, and must have come from some other source.

In recent years another explanation has appeared that fits like the missing piece of a jigsaw puzzle. A marine biologist, sent from England to investigate a disease sweeping the sponges of the Bahamas and ruining an important fishery, spent several years among the small islands of which one should be San Salvador. His answer, of all things, is worms!

The worms spawn every month, winter and summer, but they pick their own time. They will not expose their elfin lights to the withering competition of the sun or the moon. They rise and shine only when the sun has long set and before the moon is risen. Before the moon is full, the moon is in the sky earlier than sunset, and there is continuous light. The full moon rises as the sun sinks below the horizon, and not until several nights afterwards, when the moon is approaching the third quarter, is there a fair interval of complete darkness between sunset and moonrise. And so, each month, on several consecutive nights until no eggs are left, commencing a couple of nights after full moon, the worms leave the island reefs to display their ethereal light at the surface of the sea.

Columbus saw the light at 10 P.M., two hours or so after sunset, an hour before moonrise, as he wrote in his journal. There is little doubt the fireworms were busy about their luminous duties at the time the light was seen. It is only reasonable to assume that it may well have been the same light.

So what becomes of San Salvador? If it is not Watling's, it might be Cat Island, to the south-east, or should we reconsider the Turks Islands, at the eastern end of the chain, as another contender? What really is of interest is that a question that seemed to have been settled once and for all is again thrown open to inquiry, and personally I find a lot of satisfaction in the thought that none of our final answers is truly final. All that we know, or think we know, is just our way of looking at things, and what we think of life and the universe will seem just as naïve, immature, and even deluded by our descendants a few centuries from now, as we find the thoughts and ideas of the medieval world. There was a great deal of truth in what they believed, and there is a remarkable amount of fancy in what we are sure we know now.

Still, we are pretty safe in assuming that it does make a difference to our charting of a course whether we consider that a compass needle points to the true north or to the magnetic pole.

With information now available William Hobbs has recharted the course of the *Santa Maria* according to the compass bearings corrected for the magnetic deviation of 1942. There is a great difference. The uncorrected bearings as recorded in the diary take the ships through the centre of the thousand-mile stretch of the Sargasso Sea and leave them running squarely against the middle region of the Bahaman Banks. The new bearings take them much farther south, along the southern edge of the Sargasso, where they gain the full benefit of the North Equatorial Current, and explain many things that are otherwise hard to understand.

Only for the first half of the voyage was there wind enough for effective steering, and after entering the North Tropical Belt of Calms steerage-way was lost and the ships for the most part simply drifted westward with the North Equatorial Current, passing in and out of the edge of the Sargasso Sea. "Soft breezes" would have had more effect on the high fore and stern castles of the ships than they would on the flapping sails. Yet current and breezes together carried them westward, but at no more than a walking pace. At that time of year, once the Canaries had been left behind, in such boats as the caravels, the drift across the tropical zone of the Atlantic to the islands of the west was as inevitable as fate.

All that was necessary was that a ship, more or less provisioned, with men on board, should start sailing west from the Canaries. No matter what the motive, or whether or not by accident, the New World would have been discovered, if not reported. This is a venturesome universe and there is usually more to be gained by getting up and starting somewhere than by sitting wondering where to go, let alone just sitting. After all, when you do go on a journey you see more and enjoy it more if you don't know where you are going and don't care when you arrive. In this age we mistake speed for travel.

I went to school in the ancient city of Bristol and each day passed by the tall Cabot tower standing on its high hill overlooking the river harbour which used to be the second maritime port of England. John and Sebastian Cabot were names to conjure with, and it is only recently that I have come to know that Sebastian was a deceitful and unscrupulous son of a very worthy father. John Cabot sailed from Bristol aboard the *Matthew* no more than five years after Columbus commenced his first voyage, and Sebastian, who may or may not have accompanied him as a very young man, has led us to think that he himself was the moving spirit of the voyage which discovered Newfoundland and Nova Scotia. The Cabots were Venetians, and what they were doing in England, then and later, is something else. What has puzzled me at times has been this original voyage of John Cabot. Central America was being discovered, there was an easy route to it through the tropics, Spain had not had time to close the door—why should Cabot have taken the course so far to the north, with head winds most of the way, and limit discovery to the lands of the Labrador Current and then hurry home? As a Venetian, I doubt if he knew of Eric the Red.

The answer, I think, is to be found in Venice itself. There were two rather dashing and wealthy brothers of that city, the brothers Zeno, who had sailed into the Atlantic and away into unknown parts, adventuresome fellows who could tell a tall story, or so it seemed. For they returned with tales of new lands in northern seas.—When was this? In 1390, more than a hundred years before Columbus! Perhaps little weight was given to their reports, perhaps it all sounded too bleak and cold to attract any other sailors from the sun-drenched Adriatic. But there is little doubt that in the aristocratic trading circles to which the Zenos belonged the story was well known and familiar to several succeeding generations. How could a bold and well-placed mariner like John Cabot have failed to know of it? He may have been as sceptical as the rest until Columbus sailed west and discovered new lands. Then the Zeno story clicked and he followed their course to the islands they had reported. It is too much of a coincidence to be otherwise.

Why the Zenos have not been given the credit they deserve is another matter entirely. They did leave a map and a well-authenticated account of their explorations, but Venetians held their trading-cards close to their chests, those most concerned knew what they needed to know and the rest weren't supposed to. So it was not until the middle of the sixteenth century that the map and the narrative came to be published, and they have been generally discredited.

The Zenos claimed to have sailed for many days due west from Iceland to an extensive New World and to have made a landfall on a mountainous island about the size of Iceland, which could only have been Newfoundland. Yet a course due west from Iceland should have brought them to Greenland after sailing less than four hundred miles, and modern historians have remained sceptical.

The man who has come to their rescue is again that most eminent geographer, William Hobbs, who has been brooding *over the Zeno map of Greenland. No man is more familiar* with the coastline of that over-weighted relic of the Ice Age, for he was director of the University of Michigan expeditions to Greenland.

The issue was apparently clouded by the action of the publisher of the map in superimposing a series of parallels of latitude upon it with entirely false values, whereas the astrolabe, or primitive sextant, which Columbus relied upon so heavily, only came into use by mariners after the time of the Zeno explorations. Hobbs uses this fact, together with that of the prevailing ignorance of the times concerning the existence of magnetic compass variation, to show that the map is genuine and carries within itself its own proof of validity. No one in the sixteenth century could have read himself backwards into the ignorance of the fourteenth century to have produced a map of this particular kind.

The Zeno map had no common scale, for the distance travelled could only be guessed at, and islands were given the size needed for the inscription of detail such as bays and capes. And the large clockwise rotation of Greenland on the map, which has been a stumbling-block to acceptance, is easily explained and could not have been otherwise drawn in the fourteenth century. For the Zenos were among the very earliest of the deep-sea explorers to steer by compass, and they used the primitive form just then coming into use, a splinter of loadstone thrust through a raft of cork and floated in a basin of water. It was supposed to point to the celestial north, and where Columbus encountered variation to the extent of a point to the west of north, the unsuspecting Zenos were off by as much as half of a right angle. When the map is rotated to correct for variation and allowances are made for lack of knowledge of latitude and distance, it becomes completely convincing. At least, so Hobbs finds it to be, and I find myself persuaded.

With the map reinstated, the narrative also comes into its own, and the Zenos become not only discoverers of Newfoundland and the American mainland but explorers who took in the whole of the east coast of Greenland and included Spitsbergen to within ten degrees from the pole. It is an amazing venture, that demanded skill and perseverance and a light heart far surpassing Columbus'. What they failed in doing was to open the right door; it was too far north, much too uninviting.

3

THE LONG VOYAGE HOME

The islands rose as low green jewels, ringed with dazzling white beaches of crushed coral and seashells, lost in the sapphire blue of the deep sea, save where water shoaled and the sand sent back in greens and yellows the blazing tropical light. They bore the children of the dawn—comely, gentle, naked people whom the Spaniards found without guile and without armour. Columbus was much taken with them and with the beauty of the isles, but his purpose was unfulfilled and he could not linger. So San Salvador got its name, and he went on to take possession of all the little islands for the sovereigns of Spain. Throughout it all he was searching for Cipangu, described by Marco Polo as having pearls in abundance, and he had no idea whatever that this was a new world entirely, that he was the vanguard of a succession of men who would see it with ever-increasing clarity and probe its past as well as explore its depths. Cipangu, or island of Japan, and the courts of Kublai Khan of the Asiatic mainland were his immediate objectives, and gold was now the sign to be followed in place of birds and weed. Some gold decorated the Lucayan Indians, which they said had come from the south, and so to the south he went. What course he took, which of the Bahaman islands are Santa Maria de la Concepción, Fernandina, and Isabella, and where Cuba was first sighted have never been too certain. Now, a new needle demands a new thread, and a man with a chart and the journal, time, and a boat could make a voyage of enchantment.

On the day of landing—Saturday, 13th of October (San Salvador)—a fateful day for the races of two hemispheres—Columbus wrote: "As soon as dawn broke many of these people came to the beach, all youths, as I have said, and all of good stature, a very handsome people. Their hair is not curly, but loose and coarse, like horse hair. In all the forehead is broad, more so than in any other people I have hitherto seen. Their eyes are very beautiful and not small, and themselves far from black, but the colour of the Canarians. Nor should anything else be expected, as this island is in a line east and west from the island of Hierro in the Canaries. Their legs are very straight, all in one line, and no belly, but very well formed. They came to the ship in small canoes, made out of the trunk of a tree like a long boat, and all of one piece, and wonderfully worked, considering the country. They are large, some of them holding forty to forty-five men, others smaller, and some only large enough to hold one man. They are propelled with a paddle like a baker's shovel, and go at a marvellous rate. If the canoe capsizes they all promptly begin to swim, and to bale it out with calabashes that they take with them." Such were the Lucayans, and so were they found to be throughout the Bahamas, Cuba, and Hispaniola—a gentle breed, migrants from Yucatan following the island chain to the east. And everywhere Columbus went he found only fisher-farmer folk cultivating beans and yams, whose only vice seemed to be the carrying of "half-burnt weeds in their hands, being the herbs they are accustomed to smoke". Tobacco was discovered!

November was spent coasting along the eastern shores of Cuba, landing here, there, and everywhere, and at one place "there was a beautiful meadow, and many tall palms. They found a large nut of the kind belonging to India, great rats, and enormous crabs—many birds, and there was a strong smell of musk. They also fished with nets, and among many others, caught a fish exactly like a pig, not like a tunny, but all covered with a very hard shell, without a soft place except the eyes. It was ordered to be salted, to bring home for the sovereigns to see."

The crabs were those that now climb the palms for coconuts and have claws strong enough to open them or to crush your fingers. Coconuts were yet to reach the Caribbean, and the crabs sought other food. More exactly they are giant hermit crabs, not true crabs, which have dispensed with borrowed snail-shells, have managed to harden their originally tender rear, and have grown to a size far beyond what a snail-shell could have covered.

It seems a pity that Columbus only came across the scent of a skunk already gone about its business, for a full face-to-face and rear encounter would have raised Cain in more ways than one! The musk known to Europeans was the milder version carried by the badger; and our straight-shooting beauty was a surprise yet to come. Later fishermen also caught the pig-like fish, for it is a common reef fish with a hard, rigid skin-covering of large scales cemented together, but it has a pair of prongs projecting forward from the head and it is better known nowadays as the cow-fish. Perhaps Columbus was more familiar with pigs and goats than he was with cows.

From the eastern end of Cuba, Columbus saw high land in the distance and set sail for it. The new landfall was Hispaniola, destined to become the head-quarters for the Spanish conquistadores through the coming century. It was his greatest discovery and he named it Hispaniola after his adopted homeland. But for Columbus himself it became increasingly a symbol of bitter tragedy. On Christmas Day the *Santa Maria* ran aground on a coral sandbank close to shore and was wrecked. Pictures usually show the vessel storm-tossed in the surf on a rockbound coast, but "all had fallen asleep, seeing it was a dead calm and the sea like glass, the tiller being in the hands of a boy, the current carried the ship on one of the sand banks. . . . The ship ran on it so gently that it could scarcely be felt," and but for a panicky crew they might have got her off! If they had done so, I wonder if the world would have been the same. The ships might have gone elsewhere, never to return home. As it was, it was in this same region, ten years later on his fourth and last voyage, that Columbus and his men were forbidden to land on Hispaniola by the armed Spanish forces already in full and merciless occupation, when, in unhappy frustration, he sailed onward and discovered the whole Caribbean shore of the Panama Isthmus, the American mainland at last!

After the shipwreck he became decidedly uneasy. Martin Alonso Pinzón had already deserted in the *Pinta* in November, and Columbus was uncertain of his own authority on the *Niña*, which had Martin Alonso's brother as captain. When the *Pinta* rejoined the *Niña* early in January, he decided the sooner they set sail for Spain the better—"it was not a fitting time for dealing out punishment". So the ships worked eastward along the north coast of Hispaniola, and it was during these last few days, while filling casks with fresh water at the mouth of a river, that Columbus saw the three mermaids "which rose well out of the sea—not so beautiful as they are painted, though to some extent they have the form of a human face. The admiral says that he had seen some, at other times, in Guinea on the coast of Manequeta." It is difficult to say what the mermaids meant to him, though his immediate decision to sail for home suggests that they were the last straw. My own inclination would have been to let the ship go, and settle down to watch the animals, for few are so fantastic, for what he saw were the manatees, or sea-cows, of the Caribbean Sea and great South American rivers. What he had seen off the reed-fringed, tropical coast of Africa were their close cousins, the African manatees. He recognized them as mermaids, for that was what they were known to be, but a name is only a name, and Columbus may have thought them to be half men, half fish, or he may have known better. Sea-cows do look half human as they raise head and chest out of the water to look around. For at least they are warm-blooded mammals that breathe air and bring forth their young alive, and the round head, the arm and flipper clasping a suckling youngster to the breast, inevitably suggest the idea of mermaids.

So the two caravels set forth on the long voyage home, striking boldly to the north-east by compass and even more to the north than was indicated. On the outward journey, sailing westerly from the Canaries in the grip of the North Equatorial Current, with the north-east trades blowing steadily behind, took great courage in the beginning; but when well started, the ships would eventually have been carried to the Caribbean without a navigator or even a man aboard. Yet with a full crew they could not have been sailed home by the way they had come.

I think the voyage home was no less a choice of circumstance than the first, and the ships sailed on a course between north-east and north because that was as close as they were able to sail against the north-east trades. After reaching the horse latitudes, they picked up the westerlies and could sail easterly with strong following winds, aided by the west-wind drift.

Man-of-wars and boobies accompanied them for the first two or three days, and then were left behind for good. The air grew colder and the nights longer "owing to the narrowing of the sphere" as the ships sailed to the north. Tropic birds, terns, and sargasso weed stayed with them, the sea smooth and the air temperate, for a full two weeks of steady sailing. On the 2nd of February the sea was still "so covered with weed that, if they had not known about it before, they would have been fearful of sunken rocks", for they were still on the fringe of the Sargasso Sea, though now on the northern rim of that great eddy, and beginning to make easterly.

By this time food was running low and it was fortunate that the sailors caught a very large shark—probably a basking shark—"which was very welcome, as they now had nothing else on board but bread and wine, and some yams from the Indies". Yams were already known, for the Portuguese had brought them back from the East Indies to Africa and Europe, but the yams in this case were sweet potatoes from Hispaniola, not true yams at all, but potatoes that become all-important when we try to settle the present debate on who settled on the Polynesian Islands of the Pacific, the Polynesians or *Kon-Tiki*!

During the night of the 13th the ships had lain hove to in a high and tempestuous sea. As the storm grew worse, lots were cast as to who would make a pilgrimage to Our Lady of Guadeloupe in case their prayers were answered, and the lot fell to Columbus. He began to fear that his sons would be orphaned and that all knowledge of his voyage to new land would perish with the ships. So he wrote a hasty account of his discoveries on parchment, put it wrapped in wax cloth in a wooden barrel, and cast it into the sea, one item that probably did end up in the heart of the Sargasso Sea! This was the storm that brought to his mind the recollection of the trees he had seen growing "even within the sea". These were the mangroves of the tropical islands, with their roots in the sea, and he interpreted their peculiar growth to mean there could be no great storms in the countries he had discovered. At this time he had not experienced a hurricane, which mangroves withstand well; when at last, at the end of his final voyage, Columbus did encounter a tornado, he took it to be the second deluge! With what was in his mind I think you would have felt the same.

The sky cleared during the night and with the following sunrise land was sighted, they came to the Azores, and at last to Spain—crossing the bar at Saltes to anchor once again off the little town of Palos.

4

THE GARDEN OF THE QUEEN

Six months later the second voyage began and Columbus left the white-walled harbour of Cadiz under a radiant September sun. We have two reports on it, one in the form of a letter written by a Dr. Chanca to the councillors of the city of Seville, and the other a secondhand account by a simple parish priest.

Once again the course is set for the Canaries, and three weeks after leaving those islands land is seen to the west, according to the pilots' reckoning, eleven hundred leagues from Cadiz. Chanca remarks, "So I do not think that anyone had not seen enough water!"

This time the course is somewhat more southerly and the landfall is the small, steep island of Dominica, with Guadeloupe following at once. The islands were beautiful, but the native men were wary and none could be captured, and those they did take were women and boys, themselves already captive. They had discovered the islands of the Caribs, rumours of which had reached Columbus in Cuba the year before. No wonder the Lucayans to the west went in fear and horror, for the Caribs, colonizing the chain of small islands leading north and west from the South American mainland forests, as far as Puerto Rico, were the original cannibals of the Cannibal Isles. They were as fierce as the Lucayans were gentle, and raided the islands to the west for any prisoners they could take.

I have always thought that the Virgin Islands were so called because of their quiet unspoiled beauty, but the name, it seems, carries a more sinister quality. They lie midway along a trail, where the Greater and Lesser Antilles meet, where two migrating races of men came face to face but had no room to pass, one of them the descendants of the temple-building Mayans, the other fierce hunters from the Amazonian jungles. The Virgin Islands got their name from the early rumours that on them lived only women, mostly young and handsome. It sounds glamorous enough to take a young man's fancy but, though true enough, the truth was deadly.

The Lucayans were civilized agriculturists, the Caribs were savage meat-eaters with a passion for human flesh, and I doubt whether cannibalism had ever been carried to such a logical, low, materialistic level before. Elsewhere mystic rites of creation and the spirit have been involved, but the Caribs merely regarded the Lucayans as a race of domestic animals and behaved toward them like cattle-ranchers, keeping some as a breeding-stock and slaughtering the rest for meat. The procedure was entirely practical. In a village on one island the Spaniards found fifty houses with not a male among them. The Caribs had simply gone in and either killed or taken all the men. Those who were killed were eaten on the spot, the rest were taken back alive and eaten at leisure. In one Carib hut Chanca found the neck of a man cooking in a pot and human bones all over the place gnawed clean of everything that could be eaten. Boys were taken as well as men but, since their young flesh was less palatable, they were castrated, kept as slaves until they were fully grown, and then put into the pot! The older women were usually left as a brood stock, the younger and more attractive ones were taken back as slaves and concubines, but of the babies born to them by their Carib masters, only the females were allowed to live. The males were eaten at birth.

The effect is horrible and the Spaniards were horrified, but I do think we are inclined to confuse two very different aspects of this practice—eating human flesh, which is revolting unless you have been brought up in a cannibal world, when obviously it is not, and killing a man in order to profit by his death. From the point of view of the victim I can't see much difference between being killed for the stewpot by Caribs or driven more slowly to death as a pack-horse or gold-digger by Spaniards. One was as callous as the other, and our sensibilities, I believe, are beside the point. In courage, loyalty to their own, and in fierce independence, the Caribs were the equal of any. Nor is the matter of castration in itself a greater outrage than Caesar's cutting off of the right hand of rebels in Gaul, or Spanish overseers in the time of Humboldt's visit to Brazil who cut the hamstrings of Negro slaves suspected of intending to escape.

The great arc of islands, the Greater and Lesser Antilles together, reaching all the way from Central America across the Caribbean to the delta of the Orinoco, serves as stepping-stones for island-hoppers besides human beings, and by one means or another many a tropical animal has found its way from the mainland, particularly from Yucatán to Cuba and Haiti. For most of them the islands have been a dead end, an asylum in which much has happened, though in isolation from the rest of the world. Yet they remain symbolic, and show that given time enough forest animals do manage to travel along an island chain, without doubt by accident and not by design. These islands have been important only to themselves and their occupants and have probably never served as a truly effective bridge. But farther to the west, where the Isthmus of Panama stands now, other islands used to be, and these, as we shall see later, did serve as a highway for certain forms of life during the enormous period of time when the isthmus did not exist.

The voyagers went on to Hispaniola, and Chanca is much taken with it, for he wrote: "There are innumerable great rivers and mountain ranges and large open valleys and lofty mountains. I imagine that the foliage is green all the year round. I do not believe that there is any winter in this island or in the others, for at Christmas many birds' nests were found, some with small birds in them and some with eggs. Neither in it nor in the other islands has any four-footed animal been seen, except dogs of various colours—There are no savage animals. There is, further, an animal, the colour of a rabbit and with similar fur; it is the size of a young rabbit, has a long tail, and hind and fore feet like those of a rat. These animals climb trees and many who have eaten them say that the flesh is very good to eat. There are many small snakes. There are not many lizards, and so the Indians make a great dainty of them as we make of pheasants at home. In a small islet, however, which lies near a harbour that they call Monte Cristi, where we stayed many days, they saw on many occasions a very large lizard, which they say was as great round as a calf, and from tip to tail as long as a lance. They went out many times to kill it, but owing to the thick undergrowth it escaped from them into the sea, so that they were not able to come face to face with it."

The rabbit-furred animal I believe to be the agouti, a tree-climbing rodent common throughout Central America; the great lizard was an alligator, and a face-to-face encounter might have been unexpectedly disturbing. The dogs are the same "dogs that could not bark" that Columbus saw throughout the islands. They were domesticated by the Lucayan Indians and used as food, and owing to the shortage of provisions after reaching Hispaniola on this voyage, the Spaniards ate them too, finding the taste not unpleasant after they got used to it. In fact within thirty years or so of the first discovery of Hispaniola the Spaniards had eaten all these muted mammals, and we can only conjecture what they really were. Dogs they most certainly were not, and the best candidate for the post seems to be the coati.

What are the provisions? Hairy, four-footed animals somewhat the size and appearance of dogs, that ran with a dog-like gait, more or less domesticated, but with no bark. They were not seen on the islands of the Caribs, but were common wherever the Lucayans had settled. So they must either have been already present on the larger islands or brought there by the Lucayans from the Yucatán peninsula. Either they hopped from island to island in the canoes with the Indians or they drifted with wind or current clinging to storm-uprooted trees. The coatis could have made the trip with the natives, for young coatis make intelligent and gentle pets and are as inquisitive and mischievous as their northern relatives, the raccoons! Their real home is tropical America from Central South America north to Arizona. On the ground they often run in packs like dogs, with pointed, dog-shaped heads, and tails held straight and high in the air. They have short brownish hair, but the loudest noise they can make is an almost bird-like scream. So everything seems to fit. They dig just like a dog, with forepaws going one after another, for grubs, or climb trees like wild cats, in search of nuts, fruits, and birds' eggs. Sometimes when one band is leaping through the branches another runs below, picking up the nuts that are shaken down from above. In the tropics, however, much of their time is spent climbing about trees in search of sleeping iguanas, although most of the big lizards are less sleepy than they seem and drop to the ground and escape.

The Indians ate the iguanas too, and once the Spaniards overcame their repulsion at the smell of cooked iguana they regarded it as the greatest delicacy in the world. Until then the eminent doctor thought the native palate was completely degraded, and could not imagine how any animal, let alone any human being, could live happily on a diet of peppered yams, snakes, lizards, spiders, and worms. And so ends the letter: "But God is witness that I have not gone one iota beyond the bounds of truth." It is the letter of a highly intelligent, sophisticated man of the world and it has much to say about gold. I cannot help thinking that the hard-headed authorities of Seville couldn't decide how much of Columbus' original story was pure fairy-tale, and had sent one of their own to see for himself.

Perhaps it was this report that set the objectives and the scope of Spain's drive into the New World which immediately followed. For, while Columbus went on with his dream-like quest for glories he coveted but would not admit, the doctor's letter went home to Seville. You can imagine the response of men governing a war-impoverished country to the matter-of-fact statement that gold in nuggets and grains lay in more than fifty streams and rivers, lay in the ground throughout the island waiting to be dug up, and that the ships of the next voyage should come back laden with it. Columbus might have been disbelieved, but not the doctor of Seville who had been physician to the Spanish princess.

The rest of the journey has none of the grimness of the first half, and the account of it comes from the simple, kind-hearted, ingenuous parish priest, Andres Bernaldez, a man with some appreciation of beauty, delighting in pomp and ceremony, believing firmly in the miraculous, and loving to hear of marvels. He knew Columbus personally and entertained him after the voyage. It is easy to picture the scene, the wine forgotten, with Columbus eagerly describing what had so excited his poetic nature and Bernaldez as eagerly listening and encouraging his guest to continue, lost in wonder at the strangeness of it all.

He wrote: "So the admiral, thinking that Cuba was an island, went for a great distance along its coast." On landing they found only fires on the beach and signs of cooking, but we do have here a description of the iguana as it seemed to Bernaldez after hearing Columbus talk of it—"they were the colour of dry wood, and the skin of the whole body was very wrinkled, especially that of their heads, and it fell down over their eyes. And they were venomous and terrifying, and were all covered with very hard shells, as a fish is covered with scales. From the head to the tip of the tail, down the middle of the back, they had long projections, disgusting, and sharp as the points of diamonds." It is not surprising that it took them a while before they could look upon it as a delicacy! A little later "at sunrise, they looked from the top of the main mast and saw the sea full of islands to all the four winds, and all green and full of trees, the loveliest sight that eyes have seen". You get the feeling of ships flying effortlessly across blue water, with the material world left far behind, God in His heaven and only Eden on earth. Farther along the coast we find ourselves landing on the shore where a great grove of palms seem to touch the sky, where two fountains of water spout up out of the ground, cold and sweet tasting, "no better could be found in the world. and this cold is not harsh, as that of other waters, so as to injure the stomach, but very healthy". Everyone rested on the grass by the fountains, soothed by the singing of birds and the sweet scent of flowers.

" And from there they went by boat to a nearby river, where they found the water in it so hot that a man could scarcely bear his hand in it. And they went up it for two leagues without finding people or houses and always the land was the same beauty and the fields very green and full of an infinity of fruits, as red as scarlet, and everywhere there was the perfume of flowers and the singing of birds, very sweet. All this they saw and experienced in as many islands as they reached there. And as there were so many islands that they could not give a separate name to each one, the admiral gave them all generally as a name, 'the Garden of the Queen'."

The impression of a garden in paradise is very strong, and you feel the impact of beauty and a serene peacefulness that only a poetic, sensitive mind could convey. There is more wonder and satisfaction expressed by Columbus in this phase of his journeys than in any other and here, I think, is the clue to his real quest, a heart-rending search for things of the spirit, whether he was consciously aware of it or not.

The urge of a naturalist is here, too, an interest in the strangeness of life, a curiosity we share with the chattering monkeys of the tree-tops, if you like, for "on the following day, when the admiral was very anxious to have speech, there came a canoe to hunt fish. And they called it, hunting, because they hunt some fish with others. For they have certain fish, fastened at the tail with cords, and these fish are the shape of congers and have a large mouth, all full of suckers just like the cuttle fish, and they are very daring, as ferrets are here. And when they are thrown in the water, they go to fasten themselves on some fish; of these they do not leave hold in the water, but only when they are pulled out, which is before their prey is dead. And these fish are very active, and as soon as they have fixed on anything, the Indians draw them in by a very long cord to which they are fastened, securing one at a time and taking it by bringing the hunting fish to the surface of the water.

"So, as the hunters passed at some distance from the caravels, the admiral sent out armed boats and with care that they should not flee to land, and when they came up with them, all those hunters talked to them like gentle lambs without guile, as if they had seen them every day of their lives. They came alongside the boats, for they had one of these fish fastened at the bottom on a large turtle, and they waited to get it into the canoe, which they did."

Other Spanish accounts, of a little later time, add a few more details. They called the fish "reversos" and report that the Indians used them to catch manatees as well as turtles and large fish. Turtles too heavy to haul into a canoe were drawn ashore, while the manatee mermaid was harpooned when brought to the surface. Reversos were caught when young and kept and fed in salt water until large enough to be taken hunting. While before putting them in the water the Indians talked encouragingly to them, and induced them to let go of their prey by persuasive words and effusive thanks, or so they thought.

So far as Columbus could discover, the natives supported themselves in a harmonious dependency with Nature. Fish were caught and reared to catch turtles and larger fish for themselves to eat. Coatis, if they be the "dogs that couldn't bark" were reared and fattened on fish, to be eaten in turn. Tame herons and other birds also were kept and used for food. They made bread from grain, spun cotton of a kind for garments, and enjoyed the fruit of their trees.

"They came singing with joy, believing that the people and the ships came from the heavens; and although the Indian interpreter, whom the admiral carried with him, told them that they were men of Castile, they believed Castile was Heaven, and that the king and queen, sovereigns of those ships, whose these men were, dwelt in the sky." Such was the Eden the Spaniards discovered, and a generation or two later the race of innocents had vanished from the face of the earth, their strength, lives, and futurity all converted into fortresses and gold.

The Lucayans are no more, and it was Columbus himself who started the lethal practice of enforced labour, without apparent qualms. There was no evil intent, no true comprehension of what he was doing, although Isabella in Spain seems to have been fully aware of the inhumanity then and later.

They were a youthful race in a dream-like world, and perhaps Bernaldez and Ponce de León talked over their wine in the evenings at Seville of the tale of the cool, gushing, health-giving fountain under the palms by the seashore, starting the quest for the fountain of youth that led de León many years later to his death at St. Augustine in Florida.

The hunting fish we know more about, for it was an old story in the Old World, whether it was known in Spain or not. The Spaniards came to call it the Reverso, in the mistaken belief that it swam upside down; the Romans knew it as the remora, and nowadays we call it the shark-sucker. Its peculiarity is not a mouth full of suckers, as stated, but a dorsal fin, that starts life like the dorsal fin of most other fishes, which changes into a complex sucker or adhesive organ shaped like the sole of a shoe and divided into many compartments. The fish normally employs it to hitch-hike from one place to another, attaching itself to any convenient large swimmer of the seas, whether it be shark, turtle, porpoise, or even the manatee. It amounts to sheer laziness, for what it gets is a free ride to a free meal, by attaching itself by the back of the head to the lower side of its travelling companion and hanging on until food is reached. And there is little doubt that the hull of a ship looks as good to a remora as the belly of a shark.

There is an old legend that the remora can slow down sailing-vessels and even stop them altogether. We repeatedly find the idea in medieval and classical literature, and the fish was often drawn on Greek or Roman vases. The death of the Emperor Caligula was attributed indirectly to a remora, which was supposed to have fastened to his great galley and held it back while the rest of his fleet escaped, which at least is an excuse he couldn't have made himself. The scientific name, *Echeneis*, itself means "holding back", and older writers usually referred to it as the ship-holder; of course a remora is neither large enough nor strong enough to exert much force against a moving boat, for one kind reaches a length of only about sixteen inches and another no more than three feet, but a small row-boat might be somewhat slowed down and a number of fish might possibly make their presence known to the oarsmen of a larger boat.

Mark Antony's delay and defeat at the battle of Actium also were supposed to have been caused by the attachment of many sucker-fish to his galley, which may have been no more than a lame excuse when Cleopatra was around. I don't doubt he felt the need to explain; but why so many innocent and harmless sea-creatures have been burdened with responsibility for human stupidities or clumsiness on various occasions is a little puzzling. The need for scapegoats does not flatter us, and they should at least be good ones. And I think there is something very strange in the widespread use of the remora for capturing other fish. It reflects either the wandering of mankind or the tendency of men throughout the ages to use their ingenuity in every possible way to obtain food beyond their reach. There isn't any doubt that man is inherently lazy and will make someone work for him if he can, but it is surprising that the remora is employed to hunt fishes, turtles, and other sea animals not just in the West Indies, but in Malaya, China, the Spice Islands and north-eastern Australia. Chinese, Polynesians, Melanesians, and even the Australian aborigines isolated from the rest of the world for thousands of years, as well as Carib and Lucayan Indians of the West Indies, all use or have used the same fish in the same way.

It is a curious custom and it raises a host of questions, of a kind that crop up all the time when you probe into relationships. I don't know that clear answers can be made, and personally I can't think of a duller world than one in which all answers are known and no questions are left to be asked. For there are few activities more enjoyable than thinking—speculating, if you prefer the word—particularly when the subject is a matter of interest and not one of any practical importance. And for reasons I would hate to have to formulate, I don't think it's a waste of time!

Remoras are merely one case in many, and the main problem they raise is whether men in different parts of the world have independently recognized a good thing when they have seen it and have literally figured out how to employ a remora to catch another creature on separate occasions, or whether the inspiration struck only once and has since in some way spread around the world. Either is possible, but it is hard to decide which is true. It matters in two ways, or else not at all. A custom such as this, common to both the East and the West Indies, is symbolic of similarities or coincidences all too frequent among living beings, like the amazing and disturbing resemblance between the eye of an octopus and the eye of a man and a mouse. How much design *is* there in the universe and what does it mean?

In the other sense the remora relates to the migrations of the human race. If the inspiration to employ it for submarine hunting came but once, how has the idea managed to spread from the east to the west, if that is the way it went? Did some early Phoenician, sailing out into the Atlantic on a voyage of discovery, drift across to the Caribbean along the Columbus route never to return, but to pass along the trick of using remoras? It's most unlikely, but it's worth a thought. Or we may have something here like the question of coconuts and sweet potatoes that come into the story later on, symbols of journeys of men across the Pacific, from one side or the other.

A garden, whether of islands or flowers, cannot hold its spell forever, and we find ourselves with Columbus now entering the gulf between Cuba and the Isle of Pines, into a sea at first green and white, then white, and finally black as ink, sometimes very shallow, sometimes deep, a most disconcerting inconstancy.

The shore becomes muddy, the mangroves thick, but at last a palm-grove with sweet, fresh water appears like a clearing in a wilderness, only "along the shore they found tracks of very wild animals with five claws, an alarming thing, and they supposed them to be griffons". Griffons were expected in those days, mythical animals with the head and wings of an eagle and the body of a lion. It must have been disturbing, to say the least, to feel that a griffon was waiting for you behind the next clump of trees.

Pushing on, shallows get muddier, and mangrove swamps thicker, and many times the ships have to be dragged through bad places with ropes. There is plenty of time to open oysters clinging in clumps to the mangrove roots, particularly when pearls are to be found. Perhaps a sailor recalls the old story that oysters swim up and capture a dew-drop, which slowly congeals and becomes a pearl. At last enough is enough, the ships turn about and start homeward with wonders never yet ceasing. Seemingly millions of cormorants rose in spreading panic from the sea, to everyone's amazement and wonder. The day following, butterflies so numerous they darkened the face of the sky, remained until night, when a great thunderstorm destroyed them, and through all the inshore water the sea appeared thick with large turtles, so numerous that "it seemed the ships would run aground on them and were as if bathing among them".

And so home, and as Bernaldez himself writes, "that which has been written is enough".

5

THE EARTHLY PARADISE

COLUMBUS HAS been described as a self-educated, emotional, unpopular man, prone to self-pity, who clung stubbornly to a theory of the universe that was becoming rapidly outdated. To the end of his days he kept his belief in the kind of universe devised by Ptolemy in Alexandria some eighteen hundred years before. The earth was a globe—at least that much was right—which was poised motionless at the centre of things, and round which the heavens turned. The fixed stars, the moon, the planets, and the sun were carried by the revolving sky each in its particular course. Arctic and antarctic poles were poles of the wheeling sky, not the ice-caps of the earth as we now know it, while the lines of the equator and the tropics were likewise traced out upon the sky. The centre of the earth was the centre of the universe. The inhabitable land lay as a three-pointed mass on the top side of the world, and it was heretical to believe in the antipodes, or in people foot to foot with ourselves.

One thing always leads to another. There is never any true beginning nor any final end. Roger Bacon in England studied and wrote of Aristotle and of Ptolemy's geography, of Arab philosophies and of the narratives of travellers—a link in a story himself. But it must have been refreshing reading, and I can well imagine the surge of interest in his writings that swept across Europe at the time, for the time was ripe. For he was not so much creating an interest in the facts and nature of the world beyond Europe as crystallizing thoughts about it. The Cardinal Pierre d'Ailly wrote and quoted verbatim from Bacon, and so it went on, ideas rippling across continents and through time as long as words could be seen or heard. And Columbus read the Cardinal.

I think, if you imagine a man with little formal education, thirsting for information that would fit in with some thoughts he already had, hungrily reading everything he could lay his hands on, you begin to understand how confusion, misunderstanding, and certain convictions must have arisen. For in the wild welter of conflicting ideas swirling in an emergent Europe, only a well-disciplined mind had any chance to follow a reasoned path and, to put it gently, Columbus showed little discrimination in selecting his information. Some of his contemporaries considered his mind to be disordered, which was unjust, but Cecil Jane, in a recent Hakluyt volume on Columbus, I find completely convincing in his verdict of "disorderly"!

And so it was that Columbus imbibed ideas that seemed to him to be new but were already nearly two thousand years old—that the earth was more pear-shaped than round, that south of the equator lay the more elevated and therefore more noble part of the earth, and above it the more noble stars!

Here lies something of the real objectives of Columbus, for it wasn't gold, and even the Spaniards seem to have doubted the materialistic motives of his search for the lands of the Grand Khan. And on his third voyage, as he expressed himself in a letter to Ferdinand and Isabella, the goal that may have been in his mind from the start is at last clearly stated. It is implicit throughout.

It was no less than a search, in every literal sense of the word, for the heavenly paradise, the Garden of Eden—that he would find lands rich in material wealth and in souls to be saved, over which God would set him as ruler. He would sail west until land was reached and then turn southward along its shore, and on his first voyage he did exactly this until the wreck of the *Santa Maria* called a halt. Crossing the Atlantic was no more than a means to an end, and in this third voyage his purpose is clear both in his actions and his letters. To the south lay "a New Heaven and a New Earth", and by the grace of God he might rank with the mightiest princes of all time.

Once again the Canaries are on the course, but this time he sails south to the Cape Verde Islands and across the Atlantic within a few degrees of the equator itself, to discover the island of Trinidad. Passing along its southern shore, the ship enters the Gulf of Paria, "and in the night, when it was already very late, I heard a very terrible roaring which came from the direction south of the ship. And I stayed to watch, and I saw the sea from west to east rising, like a hill as high as the ship, and still it came towards me little by little. And above it, there came a great wave which advanced, roaring with a very great noise with the same fury of roaring as that of other currents, which, as I have said, appeared to me as the waves of the sea breaking on rocks—by chance I drew some water from the sea and found it to be fresh."

The Orinoco, through its several mouths, was pouring millions of tons per minute into the ocean, of water draining from a thousand miles of tropical rain-forest. But with no river in sight, water that flowed and roared did so because it was rushing downhill, which of course was true enough. Moreover, Columbus interpreted the mildness of the tropical air, and the shifting from east to west by the magnetic compass needle, to be evidence of a higher elevation, and "this elevation causes the variation of the circle which the north star describes with the guards . . and Ptolemy and the other wise men who have written of this world believed that it was spherical and that this hemisphere was round as that in which they lived . . but I declare that this other hemisphere is as the half of a very round pear, which has a raised stalk, as I have said, or like a woman's nipple on a very round ball—and its extremity is under the equinoxial line—I believe that if I were to pass beneath the equinoxial line, then, arriving at the highest point, I should find an even more temperate climate and difference in the stars and waters. Not that I believe that to the extreme point is navigable, or water, or that it is possible to ascend there, for I believe that the earthly paradise is there and to it, save by the will of God, no man can come—and I say that if it be not from the earthly paradise that this river comes, it originates from a vast land, lying to the south—but I am much more convinced in my own mind that there where I have said is the earthly paradise."

And so, in sublime and medieval misapprehension, the mainland of the Americas came to be discovered—and by a mystic who, searching for paradise, opened the gates of Eden to the armies of Spain.

From the sublime to the ridiculous—the fourth and last voyage of Columbus came to a sticky end, and from a cause which has menaced mariners ever since. In its climax, or anticlimax, it is an adventure story as good as they come, and as an inspiration, for what it is worth, I offer it here.

This account comes from the last will and testament of Diego Mendez, who was on the voyage and is really the hero. The villain of the piece is the shipworm, not even a worm, in spite of its name, but an elongated, worm-shaped relative of clams and oysters. Its peculiarity is its ability both to bore its way into submerged wood wherever it can be found, and to digest the wood as it goes. The boring is carried on by the action of the pair of molluscan shells, and the digestion by means of a ferment few animals possess. In warm tropical seas the hull of a ship can be riddled in no time at all, and even now large amounts of money are being spent in efforts to discover simple means of discouraging the mollusc from interfering with human affairs. Many a ship has fallen apart because of the worm, and such at last was the fate of Drake's *Golden Hind.* Even a ship seems mortal. And so we come to Diego's tale: "The ships were all pierced and eaten by worms —so that all the crews with the pumps and kettles and vessels were not sufficient to draw off the water which came through the worm holes—It pleased our Lord God that we should be able to reach the island of Jamaica, where we ran the two ships aground, and made of them two houses, roofed with straw, in which we remained, not without great danger from the people of that island, who were not subdued or conquered, and who might set fire to our dwellings at night." Columbus could see no way out of their predicament but to send a canoe to try to reach Hispaniola and ask for help.

Diego said it couldn't be done, but seeing that it was the admiral who was doing the asking, he would undertake the journey and offer up his life in a good cause. So "on the following day I drew my canoe ashore, and fixed a false keel to it, and pitched and greased it, and I nailed some boards on the stern and bow as a defence against the sea—put up a mast and sail—and took my leave". On the first attempt he was captured by Indians farther along the coast of Jamaica, but escaped to return to Columbus and make a fresh start, this time with an armed escort as far as the end of the island. "Finding that the sea became calm, I took my leave of them and they of me, with many tears, and I commended myself to God and to Our Lady of Antigua, and I navigated for five days and four nights without leaving hold of the oar, steering the canoe, while my companions rowed. It pleased our Lord God that at the end of five days, I should reach the island of Hispaniola at Cape San Miguel, there having been two days during which we had neither eaten nor drunk, our provisions being exhausted. I beached my canoe on a very beautiful part of the coast—and there remained for two days resting—I took six Indians from there, leaving those whom I had brought, and began to navigate along the coast of Hispaniola. It was a hundred and thirty leagues from there to the city of Santo Domingo, to which place I had to go, since the governor was there—There I learned that the governor had gone to the province of Xaragua to pacify it. When I heard this, I left my canoe and made my way by land to Xaragua, where I found the governor.

"He detained me there for seven months, until he had burned and hanged eighty-four chiefs, lords of vassals, and with them Anacaona, the greatest lady of the island, whom all those obeyed and served. And when this had been accomplished, I went on foot to the district of Santo Domingo, which was seventy leagues from there, and I remained there expecting ships to come from Castile, since it was more than a year since any had come. And in this interval, it pleased God that three ships should come, of which I bought one and loaded her with provisions, with bread and wine and flesh and pigs and sheep and fruits, and sent her to where the admiral was in order that he might come in her with all the people, so that they might reach Santo Domingo from there and thence go to Castile. And I myself went forward in the other two ships to give an account to the king and queen of all that had occurred on that voyage." *And so closes the fifteenth century, overstepping a little into the next.*

Columbus sailed west for all the wrong reasons, and discovered what he didn't expect, did not recognize, and did not want. His mind was full of dream-like legends that had persisted through the Dark Ages, which may have contained spiritual truth but certainly had no connection with the world as it was and as he would find it. Taken alone, I doubt if such ideas would have got him moving, for they contained no compulsion, and I think we have to recognize that the fire that stirred him into final action was the general sense of excitement pervading the world. Restlessness is contagious, and so is the feeling that momentous changes are in the air. You don't know what they are or what they mean, but the mind is alerted and things begin to happen, and men, and women, search within their souls for reasons why they should go in a certain way. I believe Bernard Shaw was right in stating that Joan of Arc knew what she had to do before she sought for justification and heard her voices. There's more to a mind than the froth on the top.

The door to the new world of the west opened because the time for it had come. If Columbus hadn't crossed the Atlantic, there is little doubt the Portuguese would have done so shortly, with different consequences. The spirit of the new age may have driven Columbus on his way, but he took virtually none of it with him, nor did the Spanish invaders who followed him. The dawning comprehension that had sent him forth went on growing where it was born, with the sun rising on a world of ever-widening horizons, and within a generation men knew the world could be encircled, that it was strange and new but no longer frightening or malicious. The wonder grows, but through eyes that are steadily clearing, and in time the fog of distance disappears and even the veil of the past becomes less opaque.

6

THE WORLD ENCOMPASSED

ONE VOYAGE succeeded another, for the urge to go places is always present and it takes but one man to show the way. Magellan succceded in finding his strait not long after Columbus' death, to lose most of his men from scurvy in the long drive across the South Pacific to his own destruction in the Philippines. He bridged the known world from east to west and lost his life in consequence. Yet the journey lives on, less, I think, because of the actual accomplishment than for the almost wild abandon, the reckless sailing beyond the edge of the world to doom and disaster, a ship finally sailing dizzily home with no captain and little of its crew. We can only hope that the first trip to the moon will succeed as well!

What is it that draws men on these journeys, like moths to a flame? It's not just a desire to travel, and I doubt if wandering through space has much to do with it. A mind, whether it's yours or whether it belongs to a bird or a cuttle-fish, needs to be stimulated and excited to function well—and then the cuttle flashes through all the colours of the rainbow, and the bird pours forth its liquid song—and I don't care if a bird is mostly emotion and without intelligence, or whether or not the song has the practical value of a keep-off sign—beauty is born. And when it is a man, it may be symphony or only a song in a bath-tub, or it may become the search for the golden fleece. Our minds are better than we know, but they do tend to go to sleep, and it's difficult to gain momentum.

Here, I think, lies the importance of these earlier journeys and the reason why any young man with inborn awareness of a life and a universe outside of himself should wander afield, if not afar. The streaming in through the senses, of shapes and movements, colours and smells, the hardness of rocks and tree-trunks, the feel of storms and burning sunlight, the taste of the earth and the salt of the sea, the sound of the wind and the crackling of fire—all these are necessary, for the world has substance and quality, and intellect can neither live nor grow alone. The meaning of things sinks into the soul through all the channels, not merely one or two of them, and the slowly evolving insight into the nature of the world which we find in the younger Hawkins and in Dampier comes to them in spite of themselves. They were born with intelligence and awareness. Sheer exposure to the world around them did the rest, in spite of the immediate desires driving them on their journeys.

Spain and Portugal between them embraced or claimed the whole of the new world to the west, and no challenge arose until late in the sixteenth century. By then the wealth from the Spanish Main was rolling back across the Atlantic in steadily increasing volume and other nations were beginning to covet the spoils. Hijacking is an old custom—older than you think—and piracy, legalized or otherwise, is merely a short cut to the profits of another man's labour, and they thought it fair enough that looters should be looted. I think it still is.

England and France also were turning eyes and thoughts to seaward, now that their nationhood was settled, and for a while sea traffic with the Spaniards was easier than direct assaults. And so, four years after a young woman had taken the throne as Elizabeth of England, in 1562, the first of her captains sailed to the west. "If any lose company and come in sight again, make three yaws and strike the mizen three times; serve God dayly, love one another, preserve your victuals, beware of fire, and keep good companie"! Such were the sailing directions of John Hawkins, from his flagship the 700-ton *Jesus of Lubeck* to his fleet of smaller ships. The course is the same as before, south to the Canaries and west to the Indies, only this time there is a detour.

The medieval outlook, both the inspiration and the frustration of Columbus, fades slowly from the minds of men. We are anything but clear of it even now. And the most that can be said of the century following the American discoveries is that the image of the new world shone more brightly through the foggy dreams of the past. The lands of opportunity lay in the path of the setting sun, though the view was spoiled somewhat by the sign "Keep off, we saw it first." The temperamental mystic who sailed west to discover paradise gives place to misty-eyed materialists with hearts set upon gold and silver, sapphires and pearls, and such things as these could bring them. It's an evil story, no matter what the glamour, but at least the new-comers were a little better able to see what was before them for what it was, and among the hordes of exploiters a man of greater understanding once in a while appeared.

Ferdinand, Isabella, and Columbus passed quickly from the scene, and so do the Indians whose murder so angered the Spanish queen. By 1517, the new King, Charles V, so alarmed at the diminishing of the Indian population, issued licences for the taking of Negro slaves from Africa, whether for reasons of compassion or of national greed I doubt will ever be known. At least there were no qualms when it came to using Negroes in the same inhuman way. It was an old custom, and black skins and immortal souls were not associated. The behaviour of the conquistadores abroad and the Inquisition everywhere, I think, implies that Spanish compassion died with the queen.

Up to a point the remedy was successful, and the Negroes undertook the work of the vanishing natives; but before long the Spanish found it too difficult for themselves alone to exploit the Indies and at the same time raid Africa for the amount of slave labour they required. They were predators, pure and simple, as egotistical as a tiger. In 1551 the slave trade was thrown open to other countries and Spain issued licences for seventeen thousand Negroes. The English adventurers enter the stage.

From Teneriffe they go to the Barbary coast, not yet to pick up cargoes already made ready for them by Arab slavers, but to go ashore to raid the Negro settlements for themselves.

And it is the old story of cannon and arquebus against more primitive weapons. Yet in the first attempt Hawkins lost seven of his best men and captured only ten Negroes, though when he left for the West Indies he had taken three hundred, and his ship was full. After a long passage made miserable—and below decks worse than that—by tornadoes and prolonged calms in the Torrid Zone, they reached the islands. The slave market at Hispaniola was already glutted; so, passing between that island and Tortuga, the traders turned south to Venezuela and sold their slaves there and at Curaçao. Heading for Cuba, they overshot Havana in the night and came within sight of the Florida coast, smack into the middle of the Gulf Stream where it pours through the straits with all its force, the spout of the kettle "so strong, that bearing all sailes, they could not prevaile against the same, but were driven back". So wrote John Sparke, the younger, who kept the register.

Consequently, Hawkins found himself seeing parts of the world he hadn't planned to visit, the rivers and forests of Florida and a passage home on the Cabot trail, north-east with the Gulf Stream and east with the west-wind drift.

Up one of the rivers they found the captain and crew of a stranded French ship, Indian women wearing gowns of Spanish moss, and pieces of what were taken to be the horns of unicorns. We in our wisdom know better, but if you were equally convinced of the existence of unicorns, why should you make the more elaborate assumption that the animals that supplied the horns had two of each instead of one? After all, there is logic as well as medieval nonsense in this sentence of young Sparke: "It is thought that there are lions and tigers as well as unicorns, lions especially, if it be true what is said of the enmity between them and the unicorns"—for, as you remember, the lion and the unicorn were fighting for the crown! There were no yardsticks to measure the distance between facts and fancy in the world about them—when all was strange, only the myths and fantasies of the past rang with any familiarity. It was no wonder, then, that they believed "the captain of the Frenchman saw also a serpent with three heads and four feet, of the bigness of a great spaniel which for want of an arquebus he durst not attemp to slay it". It is a good example of the mixed-up nature of their world—they did not know what to expect, anything made sense or nothing did, and what they did see is not seen clearly. And while the lack of a gun leads a touch of authenticity to the story, it was hearsay, and becomes just one more of those things, but when descriptions become firsthand we at least recognize what these peripatetic Englishmen were seeing. "Great fish, some the length of a man and longer, being of bigness according, having a snout much like a sword a yard long" is Polyodon the paddle-fish, the spoonbill sturgeon of the southern rivers, one of the two truly fresh-water sturgeons in the world. The paddle-like snout is used to stir up the soft mud along the river-beds so that the fish can feed upon the small animals thus disturbed.

Sparke is also impressed by the birds—and who wouldn't be?—in particular by the flamingo with its red feathers and long red legs, and "neck according to the bill red, whereof the upper neb hangeth an inch or so over the nether", and by the egret, "as white as a swan, with legs like a heron, and in its tail a plume so fine it surpasses the Ostrich!" And "of sea fowl above all others not common in England, I noted the Pelican—the lovingest bird that is: which rather than her young should want, will spare her heart blood out of her belly, but for all this lovingness she is very deformed to behold . . . with a long neck and a thick long beak, from the nether jaw whereof down to the breast passes a skin of such bigness as to receive a fish as big as ones thigh—and makes her seem so ugly." It is easy to forget that our common familiarity with the internal anatomy of birds, beasts, and fish is fairly recent and it is not so long ago that the cavity of the body was thought to be merely a rather complicated sac into which the mouth opened directly. Perhaps it needed outrageous statements of this kind to provoke the more intelligent and sceptical listeners to closer observation.

Meanwhile, after selling one of the boats to the marooned Frenchmen, to the astonished and gratified surprise of those gentlemen, Hawkins and his little fleet set off on the homeward journey, reaching the Banks of Newfoundland after much difficulty, and there sounding—taking time to catch a large number of fresh cod, and later buying more fish from a couple of French ships they passed on the way. The whole journey is neatly summed up by Sparke, with a flourish: "We came to Padstow in Cornwall, God be thanked, in safety, with the loss of twenty persons in all the voyage, and profitable to the returns of the said voyages, as also to the whole Realm, in bringing home both gold, silver, pearls and other jewels great store. His name be praised for evermore. Amen."

One success leads to another, and the wealth and repute gained from the first slave-trading trip led Hawkins on an even more remunerative second voyage, and this to an intensifying of the struggle between England and Spain for superiority on the high seas. The immediate result was a Spanish embargo on any further dealing with English slave-traders, although slaves were needed as badly as ever. The response made by Elizabeth was typical—buccaneering—whereby she supplied ships at a valuation to the adventuring firms, who took responsibility from there on. And so in 1567 a fully armed fighting fleet set sail for the Spanish Main, with Hawkins as admiral and his twenty-two-year-old cousin Francis Drake as pilot. And for the next ten years Drake himself became the devil incarnate in the eyes of Spain. Yet what meant more in the end was that all along he cherished a seemingly mad project of raising a fleet to sail to the South Sea, to Java, westwards round the world, on the lines of the Magellan voyage half a century earlier. And by 1577 a fever of speculation in exploration had reached such heights in England that he found money and means for materializing his dream. Five ships set out, ranging from the 100-ton *Pelican*, later to become the *Golden Hind*, down to a 15-ton pinnace.

After touching at the Barbary coast, Drake headed for the Cape Verde Islands, carrying with him a copy of Magellan's charts, which made his journey on to the Strait of Magellan as plain as was possible in his day. He took the long course to the coast of Brazil, leaving the Cape Verdes the 2nd of February, 1578, and "sailed 63 days without sight of land—till we fell with the coast of Brazil the fifth of April following".

The account of the crossing comes from Francis Fletcher, "preacher of the gospel, adventurer and traveller on the same voyage". He questions Aristotle and the other ancients who had stated that the Torrid Zone was uninhabitable because of the intolerable heat of the sun—"we prove the same to be altogether false, and the same zone to be the Earthly paradise in the world both at sea and land yea to the increase of things, and the Excellency of all God's creatures in that zone is 7 degrees above all other part of the Earth". And that I think is pretty close reckoning by any account!

Flying fish, bonitos, and man-of-war birds gave them the usual entertainment travellers have found at sea between Cancer and Capricorn—the tropical triangle, it might well be called.

Fletcher noted that, once in the air, the flying fish were unable to alter direction, and some idea of the calmness of the water and the small size of the ships is gained from his description of things so small that I doubt if a binocular would aid us much when used from the deck of a modern liner—"the increase of the flying fish is such that their fry do cover the face of the seas where they have spawned, which being of the bigness of gnats do sometimes scud upon the superficies of the water and sometimes instead of flying do skip from place to place like grasshoppers, practising that being young which they must use when they be old". He makes no mention of the sargasso weed, though it may have been there, since flying fish lay their eggs, of much the same size and colour as the sargassum "berries", when possible amidst the safety of the weed patches.

The man-of-war birds were seen to soar, but the Portuguese pilot on board was too readily believed when he offered his interpretation of the birds' flight in the following way: "When they slept they mounted up into the air and casting their wings abroad descended without waking, fast asleep till they came near the water, which nature abhorring they presently awoke and flying up again to fetch out the rest of their sleep as before." It was logical enough, given a false premise, for they could see that the birds never touched water, and it was thought that they never touched land either, except for the female to drop her eggs hastily in soft, warm sand for the sun to take care of. And thus a bird who rested neither on land nor on water must perforce sleep in the air.

The Brazilian coast was sighted early in April, and a week or so later found the fleet crossing the mouth of the River Plate, to make a landing where Buenos Aires would one day come into being. Thus they came to the Land of Giants. The natives were tall, the men probably averaging close to six and a half feet, the women large in other directions. For the most part the English adventurers of the sixteenth century seem to have been of a pretty stocky build, and anyone a head and shoulders taller would have seemed gigantic. Giant men and giant birds go together, and ostriches and tall Patagonians appeared to be a natural association. Even the cockles and mussels gathered on the shore were large. Ostriches, of the South American edition, seemed to be everywhere, with legs as strong and wings as weak as in the African kind. The natives ate the meat off the great thighs, made tools of the bones and clothes from the feathers. They caught them in the way most of us, as children, have already heard, although I doubt if we knew that the story was brought back by Sir Francis Drake after the first visit of Englishmen to southern seas. The ostriches generally ran in herds, with a leader acting as bell-wether. But all birds, and ostriches at least as much as most, are creatures of little brain, and a man wearing the head and skin of an ostrich, stooping and pretending to feed, was taken for a bird by the others, so that a hunter could lead a herd into an ambush where his companions lay armed with clubs and stones. How the ostrich came to be in South America at all is another story, which belongs to our time, not to Drake's.

Continuing south, the mariners found islands crowded with birds and seals, with which they stocked up their ships. The birds, says Fletcher, "the Welshmen named Pengwin, and Magellan termed them Geese". This raises the small but interesting point, how did the penguin get its name? The Oxford English Dictionary, which is the standard authority on English word origins, simply and in complete defeat assigns it a question mark. I have read somewhere, in an account of one of the early nineteenth-century northern voyages, descriptions of murres: sea-birds which also swim readily underwater even though they can still fly, which the writer said were called "penguins" by French seamen. Which bird got its name first? There is little doubt that the Welshmen named it, for "Pengwin" is as Welsh as it could be, meaning "pointed white", but whether the name was given to the real penguin and later adopted for the murre because it acts like a penguin, or whether sixteenth-century Welsh fishermen, who must have known the murres, called them penguins and passed the name on to Magellan's geese is hard to decide. All the same, it seems to me, if Welsh seamen for the first time in the South Atlantic saw white-and-black birds with pointed wings, with pointed beak and pointed tail, and exclaimed "pengwin", they were not consciously assigning a ready-made name, but were describing with one word of their native language exactly what they saw—the pointed white ones. What could be more to the point?

It was late in August before they approached the strait, and about this time, with all due ceremony, the name of the flagship was changed from *Pelican* to the *Golden Hind*. The passage through the strait into the Pacific was made with some difficulty, only to run head on into a tempest on entering the Pacific itself. No one had any idea that it was now late winter, for August meant summer-time, and the inversion of the seasons in the Southern Hemisphere had no meaning or existence to the sixteenth century. The ships were scattered and Drake was driven south far enough to realize that there was free passage between the South Atlantic and Pacific oceans, dispelling the myth of sailors and map-makers alike that an extensive mainland lay south of the Magellan Strait.

This was the last the *Golden Hind* saw of her company, and the rest of the voyage, which needs to be briefly told, is hard to believe. For after raiding freely up the west coast of South America, like a wolf in a sheepfold, for the Spanish settlements were small and Spanish ships unarmed in what had been considered to be a sanctuary, Drake continued north-west along the coast of North America, until nearly a year after his entering the South Pacific he was off the coast of Oregon. There is no doubt at all that he was probing for a north-west passage home around the top of the New World.

None was found, and he concluded that the north-west coast of America continued in the same direction until it joined Asia, a pretty accurate guess under the circumstances. The ship was taken into shore for repairs and white men met the north-west coastal Indians for the first time, to be thoroughly impressed with their manners and manhood. Drake named the country Albion, after England and her white cliffs, and with genuine sorrow on both sides the red men and the Elizabethans parted, the Indians withdrawing to the hill-tops to watch and the sailors setting their course for the Islands of the Moluccas. To my mind it must have taken the same courage to do this as it will take when the first men take off from the earth for a rocket trip to the moon. For the Pacific had been crossed but once before, by Magellan in the Southern Hemisphere, with death and disaster as close companions. "And so having nothing in our view but air and sea, without sight of any land for the space of full 68 days together, we continued our course through the main Ocean", when, after threading their way through the Philippine Islands, they came to the Moluccas.

The rest seems plain sailing on a known course, though less plain than it might have been, for after becoming stranded on a coral reef and making a better job of getting off again than did Columbus, the *Golden Hind* sailed into the English Channel, loaded with gold and silver, a good twelve months later.

7

BETWEEN WIND AND WATER

THE WORLD has shrunk. It is not only round but a man can sail around it, and in a reasonable amount of time. Not all of it is known, but now the unknown can be measured. The earth becomes a sphere of certain dimensions, and for the first time, I think, men begin to feel at home, awed perhaps, but not so frightened.

The Armada from Spain sailed up the narrow seas between France and England into the arms of disaster. Elizabeth's captains had long since tired of trading slaves to the Spanish colonies and had taken a simpler approach to wealth by stripping the Spanish galleons sailing home from the Isthmus of Panama. Hence the Spanish punitive expedition and a state of war. Hawkins and Drake, now knights and older by two dozen years, met the Spaniards and scattered them.

Hawkins had a son, Richard Hawkins, reared among the shipyards, who commanded the *Swallow* and set fire-ships adrift into the Armada as the fleet sailed up the Channel. A few years later, in 1593, Richard was given a commission on the *Daintie*, a ship so named by Elizabeth herself when she was rowed around it, "pleasing to the eye, profitable for stowage, good sail, and well-conditioned"—fit for a voyage by way of the Strait of Magellan to China and India. And in November the *Daintie*, accompanied by a 60-ton pinnace and a victualler, left the Thames to sail westward down the Channel. On the way they had good company, for "the fleet of Flanders—came towering into the road, the admiral headmost and the rest of the men of war spread alongst to the windward".

Now the new course is followed, already set by Drake, south to the Magellan Strait, up the west coast of South

America as far as the equator, and then westward around the world. Such was the intent.

The mists from the Dark Ages were clearing away, though they remained overhead. Shakespeare, two years younger than Richard Hawkins, is in full creation, and Galileo, also a man of thirty, reaches for the stars. There is a sweep and grandeur to imagination now, and the age that produced such giants as these stands forth in the light of the sun. Yet the earth has not commenced to spin, and remains stationary beneath the wheeling firmament, for Galileo with his telescope, with the new universe of Copernicus at the back of his mind, has yet to challenge the old-established scheme of things. A great challenge matures slowly, and he needed more time to develop the power of his mind to the point where he could oppose and shake to its foundations the cosmogony of the Church and the medieval world.

And so for all the fact that young Hawkins now saw his world with the intense curiosity of startled intelligence, the night sky is still that of the ancient Greeks. For, after trouble in a storm at Plymouth, difficulty recovering his crew from the taverns of the town, and sailing south to the Cape Verde Islands, he has this to say. "The moon also in this climate, as in the coast of Guinea, and in all hot countries, as the planet most prejudicial to health, is to be shunned—I have heard say that there is a star which never separates itself from the moon but a small distance; which of all stars is most beneficial to man. For where the star enters with the moon, it makes void her hurtful influence, and where not, it is most perilous." So much for Jupiter!

Leaving the islands, the three ships ran into white water, and then sighted the Guinea coast, supposed to be eighty miles away, an "error such all men fall into where are currents that set east or west and are not known". Then came the three-month crossing of the narrow waist of the Atlantic from Africa to Brazil, against fitful and contrary winds, with more than enough time to watch the life in the sea and to think of other times. Hawkins recalls an earlier voyage. "The experience I saw in 1590, lying with a fleet of her majesties ships about the islands of the Azores, almost six months; the greatest part of the time we were becalmed: with which all the sea became so replenished with several sorts of jellies, and formes of serpents, adders, and snakes, as seemed wonderful: some green, some black, some yellow, some white, some of divers colours; and many of them had life, and some there were a yard and half, and two yards long; which had I not seen, I could hardly have believed—a man hardly could draw a bucket of water clear of some corruption." With his mind awake, he was lost in wonder, not knowing what he saw and fully aware of his ignorance. As a marine biologist I can only guess that he saw Venus girdles, chain salps, Portuguese man-of-wars, and other siphonophores, all beautiful to behold, all living animals little more than coloured sea-water themselves. In our own age I think anyone would be struck with wonder at their beauty of form and movement, for they are oceanic creatures of a purity and elegance that go back almost to the beginning of time, all forever struggling to keep close to the surface of the sea where light and life are one. "Corruption" is a word that brings an image of evil and decay, and I believe that here it is more than a matter of old-fashioned usage, and that Hawkins was truly reflecting the ideas of his time. For it was commonly believed that the earth was degenerating, that seasons were becoming irregular, that noble forms of life were disappearing one by one, and that corruption in the form of worms and serpents and other creeping, crawling things was taking their place. It's a little like the theory of evolution upside down, the film run backwards and the music soured and discordant in reverse.

But in reality the creatures he saw were lovely oceanic forms that shun the coastal waters, to be seen from small wooden sailing-ships but not fast modern liners—and I whose business it is to know them have only seen them dead and pickled, and feel green with envy.

On that occasion his ship was the only one virtually free from scurvy, and considering the times it is amazing how good his precautions were: "Keep off salted meat and fish (that is, eat fish freshly caught), keep clean, take exercise, drink much watered wine or beer, and, most fruitful of all, sour oranges and lemons." More than four centuries before vitamins were ever thought of, Hawkins had selected a diet rich in antiscorbutic vitamin C, with added rules for the keeping of a healthy body. Yet the last rule of all belongs to the century in which it was made: "But principal of all is the air of the land, for the sea is natural for fishes, and the land men"—and who can gainsay it?

Crossing the equatorial Atlantic from Guinea to Brazil was another matter, for supplies ran low, and the all-important fresh fruit gone long ago, and toward the end of the crossing death from scurvy occurred every day. In spite of all this, or perhaps partly because of it, "In this time of contrary winds, those of my company which were in health, recreated themselves with fishing, and beholding the hunting and hawking of the sea, and the battle between the whale and its enemies, which truly are of no small pleasure."

And so commences the study of marine natural history for its own sake and for the enjoyment it brings. What caught their attention, for the most part, was the drama of the sea surface itself, the frontier between air and water, where two worlds meet. For the creatures of the air the sea was a viscous trap that they entered at their peril; for those below the surface, as a gold-and-silver mirror that defined their universe, except for the few that could break through the unsubstantial glass into the great bubble of space above. Yet only fish, with their speed and weight, could actually leave their liquid for the air and only the birds could return the visit, and few of them at that. Of the little lighter things of the air there is, I think, but one that has adopted the ocean surface—the water-strider—an insect with long legs, which is light enough to run across the water, gathering for its food those helpless tiny creatures caught in the invisible surface film. It is a curious exploitation and depends upon the birds, for water-striders lay their eggs on floating sea-bird feathers.

Of the big fishes "the dolphin I hold to be one of the swiftest fishes of the sea, like a bream but longer and thinner, with very small scales, the colour of the rainbow—its head different from other fishes, for the mouth goes straight upward like the cutwater of a ship". And once, "out of the West Indies we met a school of them, which left us not until we came to the islands of the Azores, more than a thousand leagues".

"The dolphins and bonitoes are the hounds, the alcatrazes the hawks, and the flying fishes the game; they fly best with a side wind, but longer than their wings be wet they cannot sustain the weight of their bodies; and so the greatest flight that I have seen them make has not been more than a quarter of a mile—and ordinarily he that escapes the mouth of the dolphin or bonito, helping himself by his wings, falls prisoner into the hands of the alcatraze, and helps to fill his crop."

Bonitos are large mackerel or small tuna, whichever way you like to look on them, and the alcatraze is our old friend the frigate, or man-of-war bird. Columbus watched them, Drake watched them, and now Hawkins.

How flying fish fly has been a controversy ever since, but there is nothing wrong in Hawkins's account, so far as it goes. They do fly at all angles to the wind, and not only head into the wind, as so often is stated—and trust a sailor watching for the wind to know if flying fish sailed across or into the breeze. Whether it is true flying depends on your definition. It is flight in the sense that gliders fly, and in some ways I feel that a man soaring in a glider is closer to real flight than he will ever be in a jet plane. The fish swims fast toward the surface, spurred by the onward rush of a dolphin or bonito, with both pairs of fins folded against the body. It breaks through the silver mirror of the surface, spreads out the great pectoral fins to support the front part of the body, and taxis on the water, propelling violently with the tail, which has a long and strong lower lobe. As the fish gains power its whole body shakes, the tips of the pectoral fins vibrate, giving a false impression of rapidly beating wings. It shoots into the air at a speed of not less than thirty-five miles an hour, with pelvic fins now spread out as well, lifting the tail from the water, and the rigid glide is on. The flight rarely lasts more than half a minute or more than three hundred yards, although at the end of one a flying fish may drop its propeller and work up enough momentum for another take-off.

The other fish that held the attention of the crew were the sharks, of more than casual interest to all sailors before the age of steam. Hawkins's description is vivid and to the point. "I have seen them eight or nine foot long; its head is flat and broad, and its mouth in the middle underneath, as that of a skate; and cannot bite the bait before it except by making half a turn; and helps itself with its tail, which serves instead of a rudder. It is the most ravenous fish in the sea, for it swallows all that it finds. In the stomach pouch have been found hats, caps, shoes, shirts, legs and arms of men, ends of ropes, and many other things; whatever hangs from the ship's side is sheered as though with a razor; for there are three rows of teeth on either side, as sharp as nails, and good for toothpicks. . . . And I have been informed that in the 'Tiger', when Sir Richard Grenville went to people Virginia, a shark cut off the leg of one of the company who was sitting in the chains and washing himself. They spawn not as most fishes do, but whelp, as the dog or wolf; and for many days after whelping, every night, before any storm or any danger which may threaten, the damme receives the whelps in her mouth and so preserves them till they are able to shift for themselves. I have seen them go in and out, being more than a foot and a half long: and after taking the damme, we have found her young ones in her belly."

The last is a good story. How much of it is true I am not sure. The last statement is factual enough, for if you open up a pregnant female shark the pups are found developing in the oviducts within the body cavity, and look and squirm like small sharks, even though they are due to be twice as long and twice as old before they are born. But they are not the ones that the "damme receives in her mouth". Any that pass down her throat enter the stomach, and that's the end of that! But whether recently born pups swim in and out of the parental mouth, I do not know. I wouldn't care to if I were a shark pup, but it is a common enough practice among many catfish, and some sharks may have acquired a similar co-operative instinct between mother and young. And an intelligent navigator with time, interest, and opportunity for close observation is as likely to be telling the truth as any other, even if he did live in the sixteenth century.

Yet even with the best observers there is always danger of confusing what actually is happening with what seems to be taking place, and fact and fancy can become closely interwoven, as in the accounts of the whales. "Now of the fight between the whale and his enemies, which are the swordfish and the thresher. The whale is a huge unwieldy fish and it may seem strange that other fish should master him; but it is certain that frequently, the thresher and swordfish, meeting him together, make an end of him. The swordfish is not large but is strongly made, and between the neck and shoulders has a kind of sword, of a bony substance, four or five inches broad and more than three feet long, full of spines on either edge. . . . The thresher is a larger fish, whose tail is very broad, thick, and heavy. They fight in this manner; the swordfish places itself under the belly of the whale, and the thresher upon the rim of the water where, with his tail, threshes upon the head of the whale, forcing him to give way; which the swordfish perceiving, receives him upon his sword, and wounding him in the belly and forcing him to mount up again (besides he cannot stay long under water, but necessarily must rise up for breath): and when in such manner they torment him, the fight is sometimes heard more than three leagues away, and I dare affirm that I have heard the blows of the thresher two leagues off, like the report of a gun, the whale's roaring being heard much further."

Much of this is true. The swordfish here is better known as the sawfish, and is one of the giant rays, sometimes reaching a length of thirty feet, while the sword or saw is a forward extension of the snout, with a row of what seem to be sharp teeth on each side. They are not the true teeth, which are small and blunt and set closely in the slit-like mouth on the lower side of the head, but are enlarged skin denticles or toothlets. They emphasize the fact that in rays and sharks the whole of the skin is covered with what are truly minute teeth, and those in the jaws are actually enlarged editions of the same things. It is no wonder that there is no end to the number of successive rows of teeth available to a growing shark, or that in sawfish it has been a fairly simple matter to grow a couple of extra rows way out on the long snout to make it into a lethal weapon of offence!

The saw is generally used to obtain food, sometimes like the paddle-nosed sturgeon by turning over sand or mud in search of small animals buried there, or it may be struck rapidly from side to side among a shoal of fishes, stunning some to be eaten at leisure. Whether a sawfish ever attacks a whale is more than doubtful, and in any case it slashes with its saw, which is not made for fighting in the manner described by Hawkins. Which is not to say a sawfish is above slashing chunks out of a moribund whale. And they are formidable creatures, when all is said and done—one female, which towed a fair-sized boat for several miles in the West Indies, weighed over five thousand pounds. The young are born alive, and presumably for the sake of the mother the saw remains soft and flexible until after birth.

The thresher, on the other hand, is a true shark, not a flattened-out version of one, like the rays, though it is just as doubtful that it attacks whales, with or without the help of the swordfish.

Its peculiarity, as sharks go, is its enormous tail, as Hawkins describes. It is a fast surface swimmer, feeding almost exclusively on herring and mackerel. To obtain a meal the thresher often swims round and round a school of fish in ever-decreasing circles, lashing with its tail and driving the victims into a compact mass, forming an easy prey. One thresher, feeding in shallow water off the Carolinas, was seen to throw fish toward its mouth with its tail! But a thresher's mouth and teeth are much too feeble to be of any use against a whale, no matter how mad the thresher might be.

When you think of it, most stories of whale and thresher fights, including this one, appear to have been of events seen at some distance, and it is more than likely that the whale suffering torment was getting it from the jaws of killer whales, the most intelligent and bloodthirsty savages in the sea.

The noise like a gun being fired, heard from a distance of two leagues (or six miles), is also suggestive, for whales and their kind are silent creatures as far as we are concerned. The only animal in the sea that does make a sound like those described is the giant manta or greater devil-fish, of tropical waters. Like the sawfish, the manta is a ray and a fearsome one, for it grows to more than twenty feet across its disk and to a weight of more than three thousand pounds. But unlike most rays it has completely given up grubbing on the sea-floor for a living and has taken to the surface, more or less flying through the water with its wing-like fins. At times it appears to turn complete somersaults in the water, and will leap several feet into the air, coming down with a belly flop that has been described "as a clap as of thunder, which seemed to go roaring and reverberating away over the reef, like the discharge of a cannon"; the noise can be heard several miles away.

The mantas have their own method of feeding, as fantastic in its own way as the thresher's and sawfish's, though even less dangerous from the point of view of a whale. The fish has a pair of curious head-fins extending forward beyond the eyes and usually carried furled into tight rolls. When it meets a swarm of shrimp or small fish, the fins unroll and together form a scoop or funnel down which the shrimp swirl toward the mouth as the manta drives forward.

Hawkins continues with a second whale story which he heard probably from his father, for the setting is in Florida, which he had not visited himself: ". . . another manner of fishing and catching the whale I cannot omit, used by the Indians in Florida, worthy to be considered, in as much as the barbarous people have found out so great a secret, by the industry and diligence of one man to kill so large and huge a monster. It is in this manner: The Indian on discovering a whale, procures two round billets of wood, both sharpened at one end, and so binding them together with a cord casts himself with them into the sea, and swims towards the whale: if he comes to him, the whale escapes not; for he places himself upon its neck, and although the whale goes to the bottom, he must of necessity rise to breathe (for which nature has given him two great holes in the top of his head, by which, every time he breathes, he spouts out a great quantity of water); the Indian forsakes not his hold, but rises up with him and thrusts in a log into one of his spouters, and with the other knocks it in so fast that by no means can the whale get it out. That fastened, at another opportunity he thrusts in the second log into the other spouter, and with all the force he can, keeps it in. The whale not being able to breathe, presently swims ashore, and the Indian a-cock-horse upon him."

I wonder if this is not the tallest fish story ever told—or is there something in it? The whole thing is hearsay, although reasonably fresh at the time. It may not be wholly true, but I doubt if it is entirely false, for pure fiction is rarely plausible, and this is, and when it was told there were plenty of both Indians and whales off the Florida coast. Also the need of two logs is significant. The smaller whales, like blackfish, which occasionally drive ashore in numbers, have only one breathing hole, but the great whalebone whales have two, and these are the very ones which have occasionally been surprised asleep, lolling at the surface. It is not impossible that a smart Indian, leaping from a canoe on to a sleeping whale's back, might be quick enough to plug both nostrils. If the whale sounded, the pressure of water would drive the plugs farther in, and before long the animal would be back at the surface, and suffocating. It is just possible, and while I feel that "seeing is believing", it is now and forever too late, for the actors have left the stage. The rest of the story of course is pure decoration—those nice little touches which men are inclined to add to the truth whenever they repeat it.

At long last the eternal tedium of the Torrid Zone comes to an end and the Brazilian coast is reached, with all more or less suffering from scurvy, and Hawkins's first action was to send ashore for oranges and lemons: "there is a wonderful secret of power and wisdom of God, who has hidden so great and unknown virtue in this fruit, to be a certain remedy for this infirmity". The oranges and lemons were an act of grace on the part of the Spaniards, for there was still a state of war between England and Spain, and the Englishmen were not allowed to land.

Then comes one of the most surprising statements of all: "With an invention I had in my ship, I easily drew out of the water of the sea sufficient quantity of fresh water to sustain my people, with little expense of fuel; for with four billets of wood I stilled a hogshead of water." For in my ignorance I had believed that the distillation of sea-water to get drinking-water was a bright invention of modern times! Hawkins was doing it four and a half centuries ago! Yet by the time they made their landfall so many men had died of the scurvy, that they took the supplies out of the pinnace and burned the ship, dividing the crew among the remaining two boats.

Then "the eighteenth of December, we set sail, the wind north-east, and directed our course for the Straits of Magellan. The twenty-second of the month, at the going of the sun, we descried a Portuguese ship and gave chase, and coming within hailing of her, she surrendered without any resistance; she was a hundred tons, bound for Angola in Africa to load negroes to be carried and sold in the river Plate. It is a trade of great profit and much used, for negroes are carried from the head of the river of plate to Portosi, to labour in the mines. It is a bad negro who is not worth there five or six hundred pieces, every piece of ten royals, which is received in royals of silver plate, for there is no other merchandise in those parts"—a simple trade, Negroes for silver, silver for Negroes, until mines or Negroes run out.

A storm blew up off the mouth of the Plate and the master of the victualler bore up before the wind, with no signal of distress, and turned tail for England. Hawkins was now not only left alone, but with the desertion went two years' supplies of food—prelude to disaster. During the storm "certain great fowl, as big as swans, soared about us, and, the wind calming, settled themselves in the sea and fed upon the sweepings of our ship"—and now for company they have the wandering albatross of the southern ocean.

On February 10 they came to the entrance to the strait, and at the end of the first long reach and beyond, came to the island of penguins and other sea-birds. The description is vivid and brief: "The penguin is in all proportion like a goose, and has no feathers but only down upon all parts of his body, and therefore cannot fly, but avails himself on all occasions with his feet, running as fast as any man. He lives in the sea and on the land; feeds on the fish in the sea, and as a goose upon grass on the shore. They harbour themselves underground in burrows, as do conies, and in them hatch their young.

"The ducks are different to ours—and had a part of the island to themselves. In all the days of my life I have not seen greater art and curiosity in creatures void of reason, than in the placing and making of their nests; all the hill being so full of them that the greatest mathematician in the world could not devise how to place one more than there was upon the hill, leaving only one pathway for a fowl to pass between." Yet it is simple enough, if you build nests as close together as possible, though just out of reach of your neighbour's beak, this is exactly what you get—and while there remains reason for wonder, the same rhythmic spacing is to be found in a crystal. But, says Hawkins, "all of which are motives to prayer and magnify the universal Creator, who so wonderfully manifests his wisdom, bounty and providence in all his creatures, and especially for his particular love to ingrateful mankind, for whose contemplation and service he has made them all"—a devout but somewhat anthropocentric conclusion.

The ducks were cormorants peculiar to the strait, for the strait seems to breed its own kind of creatures, including penguins and the rain-soaked human beings of Tierra del Fuego.

The *Daintie* passed on through the strait, and Hawkins notes the seals, the great, brown, streaming kelp rising from the depths, makes some good suggestions concerning protection against the menace of the shipworm, gets mad at the natives, and has some hard things to say about the Prince of Darkness. Then they hit a rock, though managed to get off. At last, near the Pacific end of the strait, they anchored in Crabby Cove—"it brooked its name well for two causes, the one for that all the water was full of a small kind of red crab, the other for the crabbed mountains which overtopped it; a third, we might add, for the crabbed entertainment it gave us"—for "squalls blew down between the hills so violently we had to cut the cable and sail on the same instant, turning about with rocks beneath and the shore but half a ship's length away".

So ends the study of nature, and the pace of action quickens as the ship reaches for the Pacific. For three months or so they raided the young Spanish towns along the coast of Chile and Peru, then they crossed the equator and put into the bay of Acatames for water, the point of departure for the Islands of the Galapagos, which "are desert and bear no fruit"—and so on to the East Indies. At least such was their final intention and the plan was to set sail westward across the Pacific the following morning.

Unknown to Hawkins, a small but powerful armada was out looking for him, and before he could get out of the bay, the Spaniards came over the horizon and cut off escape to sea. Sails were raised and an inshore fight took place between, in Hawkins's opinion, good, well-armoured Spanish soldiers, who shouldn't have been trying to sail a ship at all, and good English seamen, who were so careless that their guns weren't primed and their ammunition was badly stored.

The Englishmen were taken prisoners, and after three years' detention at Lima, Hawkins was sent to Spain in a galleon which touched at the Azores on the way. And it is ironic that the ship on which he travelled was chased into the roads, with a dozen casualties, by an English fleet with Sir Walter Raleigh as one of the seven commanders, which was waiting to intercept the galleons from the Spanish Main as he himself had done years before. So he went on to Seville and to five long years of prison before an exchange of prisoners released him to England. His discovery there was tragic, for in 1595

Sir John Hawkins and Sir Francis Drake, hearing of his capture, had set out with five ships on an attempt to rescue him. The father died at sea, off Puerto Rico, before reaching land, it is said of a broken heart, and with Drake's death a few months later, after landing on the mainland, Elizabeth's golden age came to its end.

It was an age of fertility, of birth and rebirth, rather than ripening fruitfulness, echoing with the songs of poets, an ardent age when new lands and new passages were being discovered, when trading companies with the East were being formed, and English attempts to colonize Virginia were under way. The Spanish mastery of Europe was shaken loose a little here and there. New ideas were in the making but had hardly taken form, though printing-presses now were everywhere, to spread a message or print a book. The curtain is fully raised and the play begins.

II

FOUR WINDS AND THE SEVEN SEAS

8

THE FOUR WINDS

It takes time for new ideas to crystallize, and it takes more time for them to become at all widely known. For an idea starts in the mind of a single man, becomes known to a few others, and then in widening circles spreads finally perhaps to the ends of the earth. It is more than a matter of space, for a new thought may reach a distant city long before it percolates down through the layers of ever-increasing ignorance within the place of origin, and this, I am sure, was as true in the sixteenth and seventeenth centuries as it is now. Nor is a man easily classified—he may be ahead of his times in some ways and far behind in others, like the younger Hawkins, who distilled sea-water but considered the moon to be baleful and a star protective; and that was fifty years after Copernicus died, fifty years after his great book *The Revolutions of Celestial Bodies* was published, which started a revolution itself and one that still continues.

Copernicus used Columbus' discovery of America as one of his starting points, as final proof that the earth was a sphere, the conclusion Columbus was never able to reach. The earth became a globe, and "global thinking" began. But his book dropped without a splash or a ripple into the seething pool of the human mind and the ferment it carried was unsuspected. Here, I think, is the power of thought. Three centuries later, Darwin brought out his *Origin of Species* and demonstrated the power of the mind. It is not quite the same thing, for what Darwin did was to put in striking form, ideas that were already half familiar—the recognition was immediate, either as a welcome clarification or as a challenge to established beliefs. Copernicus brought nothing to a head—he left a time-bomb that went off in 1616, seventy-three years after his death, when the Holy Roman Office first recognized the threat to a Ptolemaic universe with Eden at its heart. For Copernicus's global thinking took the earth out of the centre of the universe—not too far, it's true, for he wrote: "In the centre of the Universe the sun has its residence. Who could locate this lamp in this beautiful temple in a different or better place than in the centre wherefrom it can illuminate the whole of it simultaneously?" And like all revolutions, a man who starts one cannot stop it, and it runs its course—and from mankind standing on the central stage of the universe to man on an attendant planet of a central sun, we now go on to find ourselves on a small planet of a middle-class star near the edge of a galaxy which is itself one of millions. We have lost our place, to become part of a democratic universe, and our greatest and most urgent task now is to discover what we are doing here.

Two centuries seems a long time, yet it took but three men to span the sixteenth and the seventeenth. For it happened that a few years after Copernicus died, Galileo was born: the year Galileo died, Isaac Newton was born; and before Newton died, well into the eighteenth century, the basis of modern physical and astronomical science had been well and truly laid. I doubt whether we could find anywhere such intellectual giants that stand each so squarely upon the shoulders of his predecessor. The bearers of the torch describes them better and you find it all in Alfred Noyes's "Watchers of the Sky", the flaming torch that passes from the failing hand of the worn-out runner successively into the hand of the young and fresh.

We pick up our story near the end of the seventeenth century. Galileo is dead, but he has seen and shown with his telescopes the planets that Copernicus said were swinging around the sun and not the earth, and he had placed the earth among them. Charles II, with a better head on his shoulders than the one his father lost, had already formed his Royal Society with its heretical motto meaning "we take nobody's word for it". But the Stuarts are gone, and William and Mary reign over England and the American colonies. Newton is at the height of his fame, and Samuel Pepys, now a past president of the Royal Society, keeps his diary of the life of London and the personalities he meets.

One of these celebrities was William Dampier, in his middle-aged respectability, the most amazing naturalist of all time. Dampier's story deserves a book to itself, and in fact his own account runs to two large volumes, with a third by Lionel Wafer, one of his companions. There are really three stories, all of a born naturalist and geographer, but one is of a young logwood cutter in the forests of Yucatán, one is of a buccaneer and globe trotter, and the last concerns the marooning and rescuing of Robinson Crusoe. It is the tale of adventure, of a man with much awareness and intelligence but little formal education, who sees and reflects the world from a humble level in the Age of Enlightenment.

Looking back from the lofty if uncomfortable eminence of the twentieth century, Dampier seems at first to be a cutlass-carrying pirate with an interest in natural history that is fairly common among individuals who have had a good opportunity to see something of it. We judge a man by the company he keeps—for he did keep company with pirates and he did not mistake his vocation. He must have pulled his weight, for no complaints were ever made against him by buccaneers, but it is equally clear that he took no part in drinking bouts and quarrels, and that day by day he carefully wrote up his journal, adding to his observations on nature. No man ever becomes a naturalist or any other kind of scientist without some good stimulation in the beginning and most of the naturalists I know, including myself, had during the impressionable teens some vitally interesting experiences of the living world of creatures and elements outside the deadening cities. Dampier got his on his first voyage to the Caribbean and in the logwood forest of Yucatán. And in his day there was no other way in which a young man could go farther afield for his studies than by joining buccaneers. It took great strength of purpose in the pursuit of knowledge to carry it through year after year under the most adverse circumstances. In one of the marginal notes in his manuscript he says: "I came into these seas this second time more to indulge my curiosity than to get wealth, though I must confess at that time I did think the trade lawful. As for the Actions of the Company among whom I made the greatest part of this Voyage, a Thread of which I have carried on thro' it, 'tis not to divert the Reader with them that I mention them, much less that I take any pleasure in relating them: but for the method's sake, and for the Reader's satisfaction." This book, a best seller in its time, was published six years after his return to London, when he was a man of forty.

We see him then in the light of another company, where we find him in friendship with the Secretary of State for Ireland, the president of the Royal Society, and Charles Montagu, Earl of Halifax, to whom his book is dedicated. Dean Swift loved the man, while John Evelyn wrote of a dinner with Samuel Pepys on August 6, 1698: "I dined with Mr. Pepys, where was Captain Dampier, who had been a famous buccaneer, and printed a relation of his very strange adventure, and his observations. He was now going abroad again by the King's encouragement, who furnished a ship of 290 tons. He seemed a more modest man than one would imagine by relation to the crew he had assorted with. He brought a map of his observations of the course of the winds in the South Seas, and assured us that the maps hitherto extant were all false as to the Pacific Sea, which he makes on the south of the line, that on the north end running by the coast of Peru being extremely tempestuous." Dampier's *Discourse on Winds* was published shortly thereafter.

The full title is

CAP. DAMPIER
His
Discourse
of the
TRADE-WINDS, BREEZES, STORMS, SEASONS
OF THE YEAR, TIDES AND CURRENTS OF THE
TORRID ZONE THROUGHOUT THE WORLD.

What we find here is no less than the great sweep of the winds around the earth, the impact of continents upon their courses, and wind-driven planetary currents of the oceans. He may or may not have thought of the earth as a revolving world swinging around the sun, but there is no doubt he set air and water into orderly motion. Only a very detached intelligence could have sailed for years without privacy in the company of buccaneers, and succeeded in observing and recording wind strength and direction to the extent of putting it all together in his mind, to see the wood in spite of the trees.

"Trade-winds are such as do blow constantly from one point or quarter of the compass, and the region most peculiar to them is from about 30 degrees north to 30 degrees south of the equator . . . these general trade winds are only in the Atlantick Ocean which parts Africa from America, in the East-Indian Ocean, and in the Great South-Sea. In all these seas, except just under or near the Line, they constantly blow without intermission, as well to the south, as to the north of the Equator, but not with equal force at all times, nor in all latitudes; neither do these constant Trade-winds usually blow near the shore, but only in the Ocean, at least thirty or forty leagues off at sea, clear from any land, especially on the west coast or side of any continent. For indeed on the east side, the easterly wind being the true Trade-wind, blows almost home to shore, so near as to receive a check from the land wind."

In this he almost had the world itself in movement, for the trade winds come from two cosmic forces, the solar heat reaching the Torrid Zone of the earth, causing heated air to rise at the equator, with air rushing from the north and south to replace it at the sea level, and the spin of the earth giving a twist to the movement. Trade winds blow from the north-east and south-east of the equator around the world, except where the land interferes. Just north of the line, between the two, where the air ascends, are the fitful doldrums, the bane of ships under sail—"for if they keep near the Line, they meet with great calms; and if they keep near the land they meet with the westerly winds; and if they keep in the middle between both, they must of necessity meet with both inconveniences, as also with tornadoes".

The trades, rushing toward the equator and to the west, are only a thousand feet deep, and at one time Dampier, standing high on Ascension Island, in mid-Atlantic, at a spring which still bears his name, found himself above the winds blowing half a gale below.

Passing to ocean currents—"I have hinted before, that in all places where the Trade blows, we find a current setting with the wind, which is not so perceptible in the wide sea as nearer the shores: yet even there the force of the winds constantly blowing one way, may, and probably does, move the surface of the water along with it. Hence it may be inferred that the southerly winds on the coast of Africa, and the true Trade between it and Brazil, gently move the surface of the sea with it, and the Trade being mostly at south-east drives the sea to the northward, slanting in on the coast of Brazil—thence to the West Indies." And so he lays down the course of relationship of the wind to the equatorial current of the Atlantic, which piles up in the Gulf of Mexico and runs out again at the Straits of Florida as the Gulf Stream. There was no way by which he could have discovered that the sea driven by the wind turns away from the wind direction by forty-five degrees, and that both south-east and north-east trades drive the water due west, or that the half turn results from the spin of the earth.

In the Pacific, a hemisphere in itself, winds and currents find much wider scope, and north and south equatorial currents, driven by the north-east and south-east trades, flow steadily to the west. Water is driven against the island barriers of the East Indies, piling up and looking for a place to go, some swinging to the south, some to the north into the Kuroshio current and so back to North America. But between the two equatorial currents, where no wind blows, the water piling up in the west and centre has only one way to flow, and that is downhill to the east where it came from, forming the equatorial counter-current, all the way from the Philippines to Panama.

As Dampier says, the trades blowing toward the west reach to the eastern shores of the land lying in their way, but off the western coasts of the continents the situation is different. The true trade winds pick up force several hundred miles from the western coast of the Americas, but "Southerly winds do blow constantly all the year long, on both coasts of Peru and Africa; they are brisk and blow farther off from the coasts than any shifting winds". With them moves the water, flowing to the north along both coasts, to swing west below the equator into the south equatorial currents.

Both the Peruvian and West African currents are cold, and for two reasons. The water driven to the north by the wind is replaced by cold water from the southern west-wind drift, while the inevitable 45-degree turn to the west takes the surface water away from the coast, with cold water welling up from the depths to replace it. This was beyond Dampier's understanding, for he had difficulty enough in seeing the general pattern of wind and water in two dimensions, without thinking of the massive movements of the ocean in depth. And he was much too involved in seeing things as they were to worry much about how they came to be that way, else he might have wondered how penguins came to be on the equatorial islands of the Galapagos. Of their antarctic origin he of course knew nothing, for knowledge of the existence of Antarctica was yet to come.

9

PRELUDE TO A PIRATE

THE PLAGUE was sweeping the cities of Europe when Dampier was a boy, and he was fortunate in growing up on a farm in the west of England more or less immune from the menace of the Black Death. He had such schooling as a rural area offered in his time. At seventeen he apprenticed as a seaman on a ship sailing to Newfoundland, but found that bleak province and the seas around it much too cold for comfort. Two years later, in 1671, when Henry Morgan was busy sacking the city of Panama, we find him on an East Indiaman on a trip to the Spice Islands; and on returning, joining the Navy, only to become wounded in the Dutch War.

At last, as a seasoned mariner and warrior of twenty-two years all told, the wanderlust really sinks in, and he takes the old course to the west, past the Caribbee Isles, to Jamaica, working his passage as insurance against being knocked on the head on arrival and sold as a slave—the note is struck, a lighter one than before, in this—"in a short time got into the Trade Winds, and went merrily along, steering for the Island".

Plantation work at Jamaica, even as a supervisor, soon palled—"I was clearly out of my element there"—and after half a year on a coastal trader Dampier joined a logging trip, sailing before a following wind for the Bay of Campeche west of the Yucatán peninsula, passing the Isle of Pines, Columbus' turning point on his first voyage.

The territory was Spanish and not free from danger, but most of the woodsmen were the same men who had gone with Morgan to sack the city of Panama a few years earlier, and all would have preferred buccaneering had the pickings been good. There were other dangers too, including alligators, but in this year of 1676 "two or three men went out one evening to hunt—and at last one of them fired at a Deer and killed it, and while he was skinning it, he was shot dead by one of his consorts, who fired at him, mistaking him for a Deer. The poor man was very sorry for so sad a mischance; and for fear of the dead man's friends, durst never go back again to Jamaica." It has a familiar ring, and the woods in the autumn have been hazardous ever since.

A year or two spent in the forests of the mosquito coast and nearby islands, with all the teeming wealth of tropical life of land and water around him, would either make a naturalist of any intelligent sensitive young man or would give him such a horror of biting insects and a host of other crawling creatures that he would leave the tropics forever. Dampier became a naturalist, for while he was unusually perceptive in other ways he seems to have been as tough as his companions.

For one man at least the savannahs became more than good places for deer-hunting, and Dampier saw them as they are, meadows or lakes of a long, sedge-like grass growing from deep black soil, surrounded, as oases in a desert, by higher and beautiful wooded land, "ridges of delicate woodland, and large furrows of pleasant grassy Savannahs, alternately mixed with each other". The real jungle, with its hidden and overgrown temples of the ancient Mayan civilization, lay beyond and were unknown. He lists the animals of the savannah country as deer, peccary, squashes, possums, monkeys, ant-bears, sloths, armadillos, porcupines, land turtles, guanos, and lizards—not to mention birds and insects, especially ants!

The squash is interesting, for it seems to me to be recognizable under two other names. He says it is a four-footed beast, bigger than a cat, with a head like that of a fox, with short eyes, and long nose, short legs, sharp claws, skin covered with short fine yellowish hair, and if taken young will become tame as a dog. In nature it climbs trees and feeds mainly on the fruit of sapodilla trees. This is undoubtedly our friend the coati, and the description makes it seem even more certain that this is Columbus' dog that couldn't bark!

As for the sloth, as the name implies, it goes about its business just as slowly as is possible, though Dampier jumps much too far in his conclusion. He describes it as "a fourfooted, hairy, sad-coloured animal—head round, eyes small, short nose and very sharp teeth; short legs, but extraordinary long sharp claws. This creature feeds on leaves, whether indifferent of all sorts, or only on some particular kinds, I know not. They are very mischievous to the trees where they come, and are so slow in motion, that when they have eaten all the leaves on one tree, before they can get down from that and climb another and settle themselves to their fresh banquet (which takes them up to five or six days, though the trees stand near) they are nothing but skin and bones, although they came down plump and fat from the last tree. It takes them eight or nine minutes to move one of their feet three inches forward; and they move all of their four feet one after another, at the same slow rate; they seem insensible, and can neither be frighted, or provoked to move faster."

Sloths are found only in South America and are of two kinds, three-toed and two-toed. Both move extremely slowly and deliberately, but at times have been seen even to swim large rivers, and when the spirit moves they can clamber through trees with speed enough to get away from trouble. The claws are not only large but are curved into great hooks whereby the owner hangs on its branch upside down. On the ground the same claws make walking almost hopeless, but apart from the occasional short trips from one tree to the next, a sloth spends all its life hanging in an upside-down position. As a baby it sometimes hangs upside down from the back of its upside-down mother. It even makes sloth-like love upside down. There is no tail, which seems only reasonable when you think of the nuisance one could be.

A sloth has been described as an emblem of misery fixed on an almost leafless bough, a defenceless and ready prey to any assailant, but an animal which hardly moves, has practically no voice or odour, and hangs suspended from a branch by long arms ending in hard claws, presents a problem that even a hungry jaguar finds difficult to solve. In such a situation gravity works at cross purposes, and it is the inverted sloth that comes out on top.

When the world itself is new, all is strange, and it is remarkable that Dampier saw as clearly as he did, for something completely strange is almost impossible to describe, for you can describe a thing only in terms and comparisons with what is already familiar. By reckoning a sloth is very strange, and it was seen and accepted as such. In the seventeenth century no one could have thought "What is this doing here?"—"How did it come to be what it is?" All this would come later, and I think if we ever get to Mars and see crazy-looking creatures crawling about we will ask no questions, unless to say "What else would you expect?" Knowledge of the world about us must to some extent come before we begin to wonder what it is all about, and in Dampier's time much too little was known about the living world.

Altogether, for a hairy mammal, both two- and three-toed sloths have carried invisibility to its limits, for to immobility is added camouflage. Even plants grow in the fur, some say as the result of lethargy. Certain microscopic plants grow in the grooves which run along the hairs, giving the coat a green or mossy look, and these somewhat pin-headed mossbacks survive and carry on the race by acting like the little man who isn't there.

His account of the armadillo, however, the name being the Spanish for "the little one in armour", is simple and accurate, as far as it goes. He would have seen them more in the open savannahs than in the forest—"as big as a small sucking pig—inclosed in a thick shell, which guards all its back, and comes down on both sides, and meet under the belly, leaving room for the four legs; the head is small, with a nose like a pig—on any danger she puts it under the shell, and drawing in her feet, she lies stock still like a land-turtle. The shell is jointed in the middle of the back; so that she can turn the fore part of her body about which way she pleases. It has strong claws wherewith it digs holes in the ground."

A pig in armour, shuffling about in a coat of "chain and mail", must have been startling the first time he saw it. Only the ears are naked; all the rest of the body is encased in form-fitting, bony coverings, one protecting the shoulders, another the whole rear end, with nine bony hoops in between which give flexibility to the whole. Even the tail and legs are armoured, while a flat plate covers the head from nose to crown. Only a few lonely hairs stick out here and there from the bare skin. You would think it was prepared for any emergency, but armour isn't everything, and in any case the armour is missing underneath, and a carnivore, even a peccary, which can catch it and turn it over can get a good meal. So, to compensate for vulnerability, the pig-like tank manages a surprising burst of speed when occasion demands, completing its escape by digging itself underground in a minute or so by means of the great middle claws of its front feet. Perhaps this is where the value of the armour comes in, as part of a subterranean plough capable of holding back the pressures of loose soil above it, like the shell of the desert tortoise. Both animals burrow underground to get away from the midday heat of the tropics. And when all is said and done there are few safer places to be, which may be why such perambulating pieces of antiquity are with us still. The armadillo in particular has lived on after many of its bigger and better companions have died out. So have the tree sloths. But more of this later.

As a matter of fact it would be of little use for an armadillo to turn and fight, for it has no teeth except for some peg-like back molars. It needs none for eating, for it feeds for the most part on small and squashy things, all nasty—fire ants, roaches, scorpions, and tarantulas. Surprisingly enough, an armadillo can swim, though if the crossing is short it walks on the bottom underwater.

I think the greatest claim to fame that a nine-banded armadillo has is its invariable custom of producing identical quadruplets and never anything else. This, however, may be a personal bias, for my own scientific interest is mainly in the nature of the development of organisms. At the same time the process of formation of quadruplets from a single egg is essentially the same as in the formation of twins, and you can only study something properly when you know it is about to happen. And of all the animals on the earth, the nine-banded armadillo is the only one that we know in advance will produce eggs destined to undergo a double twinning process. All we know concerning the way in which identical twins come into being is supplied by this fantastic little dirt-grubber.

A few of Dampier's animals get cursory treatment, either for too little to say or for over-familiarity. "The porcupine being a creature well known, I'll pass it in silence." That doesn't make it any less interesting, and when you consider that all the porcupines of North America are descendants of porcupine adventurers that travelled north from the southern continent, and that there are African as well as American editions of these quill-skinned rodents, their ancient travels become a puzzle. Did a pregnant porcupine ancestor manage somehow to cross the Atlantic? If so, did it float on a raft or was there a bridge to walk over? Or has the porcupine happened twice?

The opossum, which barely makes the list at all and is not otherwise mentioned, is also a South American that is pushing northward. And you have to go to Australia to find any of its kin, for outside of that desiccated continent the opossum is the only pouched mammal living on the earth. Opossums and kangaroos alike bring forth tiny premature embryos that need to continue their long development fastened firmly to the milk-teats within the maternal pouch.

Reading his notes makes you wonder whether Dampier alone saw the things he writes about, or whether his own fascination with the animals and plants around him made others interested as well. After all, one man showing signs of curiosity on a busy street often gathers enough companions to stop the pavement traffic. Certainly everything possible was put to a use, and one piece of exploitation I find disconcerting even to think about, for "here are a sort of spiders of prodigious size, some near as big as a man's fist, with two teeth, or rather horns an inch and a half, or two inches long, and of proportional bigness, which are black as jet, smooth as glass, and their small end as sharp as a thorn; they are not straight but bending. These teeth we often preserve. Some wear them in their tobacco-pouches to pick their pipes. Others preserve them for tooth picks."

Ants were found everywhere, except on the savannahs, and there is an account of their habits and enemies which is almost as detailed and accurate as that of naturalists of much later times. "The great black ant stings or bites almost as bad as a scorpion; and next to this the small yellow ant's bite is most painful; for their sting is like a spark of fire; and they are so thick among the boughs in some places, that one is covered with them before he is aware. These creatures have nests on great trees, placed in the body between the limbs; some of their nests are as big as a hogshead; this is their winter habitation; for in the wet season they all repair to these their cities: here they preserve their eggs.—In the dry season when they leave their nests, they swarm over all the woodland: you may then see great paths made by them in the woods of three or four inches broad beaten as plain as the roads of England. They go out light, but bring home heavy loads on their backs, all of the same substance, and equal in bigness: I never observed anything besides pieces of green leaves, so big that I could scarce see the insect for his burden; yet they march stoutly, and so many pressing after, that it was a very pretty sight, for the path looked perfectly green with them."

How great his wonder would have been had he known the whole story of the leaf-carriers is hard to imagine. I find it difficult to believe even now, though it has been too well described to doubt, for it is a story of instinct carried to exquisite perfection. Whether you do believe what seems to be a tall story depends partly on who is telling it; sometimes the truth is rejected because of lack of faith, as Columbus probably suspected. Sometimes the truth itself is too fantastic to be fiction, you have more faith in the unexpectedness of nature than in any man's ability to concoct the story.

In this instance it took another two hundred years before the real truth came to life. The leaf-cutters, or parasol ants, are not the ones which inhabited Dampier's tree-nests. Their home is underground except for the dome, which rises several feet above the surface, and it may have a circumference of forty yards and a total depth of fourteen feet. No wonder such a nest is called an ant city. Yet to me what goes on inside is even more impressive, for a highly organized agricultural society occupies the citadel. The leaf-cutters carry their pieces back to the nest and down to the underground rooms. You can imagine the steady traffic, though it's more like a conveyor belt in a modern factory, for the leaves are immediately attacked by groups of smaller workers who chew them to bits and shape the material into small pellets. These they place in subterranean fungus gardens about the size and shape of melons, to serve as compost upon which the fungus thrives. As long, and only as long as the ants nourish their gardens, the fungus grows juicy nodules upon which the ants feed. Not only the cutters and chewers, but the big soldier ants, the larvae, and the reproductive males and females all are sustained by the system. Is it a coincidence that factory systems and ant cities seem to have much in common or that human brains and computing machines can do the same sort of thing? The answer will be important.

Nothing ever seems to discourage tropical ants on the march, and the long columns form a never-ending meal for animals who have acquired a taste for their sharp acid and crunchy little bodies. The ant-eater is one of these, and like its not-too-distant relative the armadillo it has done away with teeth. There is nothing wrong with the way Dampier describes it: "The ant-bear is a four-footed beast, as big as a pretty large dog; with rough black-brown hair. It has short legs, a long nose and little eyes; a very little mouth and a slender tongue like an earthworm about five or six inches long. This creature feeds on ants; therefore you always find them near an ant's nest or path. It takes its food thus: it lays its nose down flat on the ground, close by the path that the ants travel in, and then puts out his tongue athwart the path. The ants passing forwards and backwards continually, when they come to the tongue make a stop, and in two or three minutes time it will be covered all over with ants, which she perceiving draws in her tongue and then eats them; and after puts it out again to trap more. They smell very strong of ants, and taste much stronger, for I have eaten them."

Misnaming it a bear was natural enough, for the ant-eater walks in the same flat-footed way with its hind feet, though its forefeet are equipped with long curved claws which are folded back beneath the wrist so that only the outer edges of the feet are actually used in walking. But in other ways it is fantastic enough. It has an unbelievably elongated head with a cone-shaped muzzle sticking out into space, with a mouth only large enough for the extrusion of the worm-like tongue, which by the way sometimes reaches a length of sixteen inches! While it has a long and luxuriantly bushy tail, often carried over the back, squirrel-fashion, always raised above the body when it is raining.

Lying on the ground with its tongue sticking out is only one way of getting food, for the strong claws are not there for nothing. They are used for ripping open the termite and ant hills, sometimes twelve feet high, of the savannahs. And if ants and termites are inadequate it will even climb trees to go bird-nesting, breaking the eggs and lapping up the mess. Generally speaking, an ant-eater asks for nothing more than to be let alone and, surprisingly enough, it is rarely disturbed. You would think a low-slung, slow-moving animal without teeth or armour would fall an easy victim to either one of the great cats, the puma or his spotted majesty the jaguar. The resemblance to a bear comes in here again, for when attacked it turns and stands, lashes out with its forelimbs and if possible embraces its attacker, sinking its claws in deep and lethally. The jungle Indians all believe that an ant-eater is capable of killing a jaguar, and when the two come together the encounter is usually fatal to both.

There are numerous kinds of monkeys in the South American forests, all a little different from those of the Old World in having thirty-six instead of thirty-two teeth and a wide nasal plate in place of a narrow one. None of them has those brightly ornamented bottoms that have been called "peripatetic sofa cushions". And quite a few have prehensile tails, which no Old World monkey would consider proper. Most of them are small and appealing or, like the capuchin, the organ-grinder's monkey, amusingly restless and clever, but there is one exception, the howler monkeys which rove in bands through the tree-tops. Dampier says they are the ugliest he ever saw, bigger than a hare, with tails thirty inches long and all bare on the underside where it is used in gripping branches. "They were a great company dancing from tree to tree, over my head; chattering and making a terrible noise; and a great many grim faces, and showing antic gestures; some broke down dry sticks and threw at me—at last one bigger than the rest, came to a small limb just over my head, and leaping directly at me, made me start back; but the monkey caught hold of the bough with the tip of its tail, and there continued swinging to and fro, and making mouths at me."

Howlers are the most ferocious-looking of the monkeys, and apparently the roaring noise they can make is simply indescribable; nothing else is quite like it. I have read that it is deafening, appalling, startling, and sleep-dispelling, lasting so long as to become unendurable. More than one naturalist has described the sound as one of all the jaguars in the forest engaged in a death struggle. Hooton, in his *Up from the Ape*, asks why it is that loud voices go with meagre wits even in monkeys, and concludes that they bluff their way through life by bellowing and roaring. There is no doubt that they do serve to intimidate, even a man like Dampier.

The howling has nothing to do with sex, for everyone takes part, particularly when alarmed. But at the first streak of dawn, from the top branches of the highest trees deep-toned roars will be given forth, to be answered by tribes in the forest around. This seems to be a form of signalling used in determining the location of the various clans, the direction of tribe movement, and in regulating territorial ranges. The last reminds us of the birds whose use of song is often the staking out of a claim to a certain feeding area, for howlers are vegetarian specialists and it is important not to crowd too close together and run out of food—so that each clan keeps its area defined by periodic howling.

Birds abound in these forests and woodlands, and Dampier did not overlook them, for among the many included in his list he was clearly impressed with the humming-birds, comparing their flight to that of insects—"very quick in motion, haunts about flowers and fruits, like a bee gathering honey, making near addresses to its delightful objects, by visiting them on all sides and yet still keeps in motion"—with "Bill-Birds" or toucans, so called by the English because of the enormous beak, as big as the rest of the bird, which is used to thrust into tangled bushes in quest of fruit—and with the beautiful hanging nests of the tropical orioles. There is no doubt that the man was a naturalist through and through, though he pulled his weight when it came to man-hauling heavy logwood in the heat of the tropics.

Cutting and hauling the purple-sapped logwood finally grew tedious, and the interest swings from the forest to the mangrove swamps and salt-water lagoons. Pelicans, crab-eating herons, and cormorants take the place of the jungle tree-climbers; and fish hawks "snatch up the prey with their talons and rise again without touching the water with their wings".

The lagoons abounded with manatees, green and hawks-bill turtles, not to mention some of the most disagreeable fish in the sea—barracudas, whip-rays, sting-rays, and garfish, which he describes as a "sort of floaty or flying fish, skipping along a foot or two above the water for twenty or thirty yards, springing forward the same distance each time they touch the surface of the water. They dart themselves with such a force that they strike their snout through the sides of a cotton-tree canoe." The similarity to flying fish is more than a matter of taking to the air, for the flying fish and the gar-, or needle-, fishes are pretty closely related. Only, while flying fish are usually flying for their lives, the gar is more likely to have been charging another fish with spear-like warhead as it is to be running away.

At long last the woodsmen set sail once again for Jamaica, and after some difficulty "to our great joy, anchored at Negril, having been thirteen weeks on our passage. I think never any vessel before nor since, made such traverses in coming out of the Bay as we did, having first blundered over the Alcrany Riff, and then visited those islands; from thence fell in among the Colorada Shoals, afterwards made a trip to Grand Caymanes; and lastly, visited the Isle of Pines, tho' to no purpose. In all these rambles we got as much experience as if we had been sent out by design."

The ending makes my mouth run dry, for Captain Rawlins of a small New England vessel, and a Mr. Hooker who also had spent a year cutting logwood in Campeche Bay, came into the cabin for a drink—"the bowl had not yet been touched (I think there might be six quarts in it) but Mr. Hooker being drunk to by Capt. Rawlins, who pledged Capt. Hudswel, and having the bowl in his hand, said, That he was under an oath to drink but three draughts of strong liquor a day, and putting the bowl to his head, turned it off at one draught, and so making himself drunk, disappointed us of our expectations, till we made another bowl—so ended this troublesome voyage."

10

ACROSS THE ISTHMUS

THE LURE of a journey, especially one without a foreseen goal, is that it leads you on and on; the pleasure lies in the continuing novelty, of surprise, adventure on a greater or lesser scale, and when it is into parts unknown it becomes hard to turn back; there is always the need to see what lies beyond the next hill or over the horizon. Excitement feeds upon itself, whether the stimulus comes from the outside world or elation from within. And once having known the tropics with their blazing wealth of life, Dampier could no more return permanently to England than he could return to the womb. His journey was to last him all his life, the longest, I imagine, that was ever made.

After a visit to London—nothing of a trip by this time—he returned to Jamaica, and at the invitation of a Mr. Hobby set out with him on a short trading voyage to the Mosquito Coast lying between Nicaragua and the Gulf of Honduras. They left Port Royal, but came to anchor again in Negril Bay at the west end of Jamaica, and that was the end of that. For in the bay lay the ships of privateers, and Hobby's crew deserted him at once and joined their more enterprising brethren. Dampier alone remained with the shipmaster, but after three or four days of his depressing company was readily persuaded by the deserters to go along with them.

I think we find here the key to Dampier's character, for he belonged to two worlds: to the intelligent, more or less refined, more or less respectable class of traders and gentlemen, and also to the rough-and-ready devil-may-care buccaneers. Yet throughout his life he never fully belonged to one or the other. In the company of ruffians there is obvious detachment, in the company of stay-at-home Londoners the wealth of his unorthodox experience sets him apart, although some of the esteem in which he must have been held is shown by the fact that his portrait was made by one of the leading painters of the day and now hangs in the National Portrait Gallery in London. It shows the face of a well-built man, with thick dark hair falling to the shoulders, a long face, with high forehead, long straight nose, a full, impatient mouth, and dark, intelligent eyes. It is the face of a grave, thoughtful, and resolute man. In a later age and with better opportunity I think he might have set the Thames on fire. As it was, he did wonders. He seems to have charmed Englishmen and Frenchmen alike, a man of modesty and courtesy except when frustration or the stupidity of fools aroused his anger. Then he was capable of outrageous action. If we judge once more by the company he keeps, we must include those who have adopted him after his death, and the company is good—great poets and great seamen. Coleridge said of him, "a man of exquisite refinement of mind", and Nelson made his children read him. John Masefield speaks of the supreme faithfulness and care of Dampier's chronicling, not that it is the work of a great intellect, although such an intellect may have remained dormant. For he goes on to say what I believe to be true, that accumulation of knowledge is one of the many pleasant ways by which men turn away from wisdom—that knowledge in itself, and unapplied, is not power; it is not even weakness. It is the comfortable, fat, and cloying thing which keeps men's souls from life. Those who give themselves to knowledge bury their beauty in the dust, and heap many particoloured blankets about their central fires. Thus speaks a poet. And it is true. The power of thought is not knowledge alone, it is the thrust of intellect as it selects this and that feature from the chaotic accumulation and builds them swiftly into a coherent pattern. Dampier did none of this, for, as Masefield says, "he judged nothing, not even himself; but his work has this supreme merit, that it surveys the lesser kingdoms with a calm, equable, untroubled, and delighted vision". Yet this recording is the sort of thing that must come first; there must be some accumulation of knowledge to start with, before understanding can begin, and above all that knowledge must be accurate and detailed, or it has little value. And so we find Dampier rejoining buccaneers, not for the blood and booty of their enterprises, which appealed to him not at all, but, as he says himself, to see what lay over the hill, beyond the bridge that joined the two Americas.

The original intention of the privateers was to return to Campeche to cut logwood, instead of which the expedition sailed for Porto Bello and sacked the town. The news of it must have reached the buccaneers remaining at Port Royal like the sound of a trumpet. So Dampier and his fellows, now turned pirates by all standards, dared not return to Jamaica, but made plans to go on to Santa Maria and across the Isthmus. When April came the company was reinforced by new-comers, among whom was Lionel Wafer, a surgeon, and needed for obvious reasons. They crossed the Isthmus and, passing through Cuna Indian villages, were rewarded by seeing the "Emperour" put on his mantle of gold over his robe of white cotton, his belt of "tygers teeth", a hat of pure gold, with a golden ring and plate like a cockleshell hanging in his nose. Their journey took them slowly up the eastern slopes of the Cordilleras, through deep and majestic forest and tangled bush, where trees, draped with orchids and vines, rose a hundred feet to their blossom-laden crowns. Gorges cut the mountain range, and through one of these the party forced its way from the rain-forest into the drier and lighter woodlands of the Pacific coast. They reached the open sea in a flotilla of borrowed Indian canoes, boarded and seized several armed ships that had been sent to capture them, and refreshed themselves on the lovely island of Taboga, enjoying the orchards and summer houses of the Spaniards within actual sight of Panama City. No foreign vessels had appeared off the Pacific coast since the days of Drake and Hawkins a hundred years before, and so secure were the Spaniards that all the guns of Panama pointed landward. Not until after this expedition—the first successful attempt of non-Spanish Europeans to reach the Pacific by land—were any guns pointed to seaward.

The whole coastline was alarmed and ships were warned to stay in harbour, so the pirate fleet steered south to Peru, still with little luck, and finally reached the island of Juan Fernandez at the latitude of Valparaiso just in time to spend a quarrelsome Christmas. There had been dissatisfaction from the start, and now it flared up in full force. The men went ashore and in typical *Treasure Island* style deposed their leader and put him in irons, though whether he was given the traditional black spot of the pirates I do not know. They suffered heavy losses in raiding the Spanish mainland towns, but Dampier and Wafer were careful to be put in charge of the waiting boats and were not as exposed to danger as the rest. In fact it is hard to think of a naturalist leading a group of undisciplined warriors into battle, and I ought to know; for you can imagine him charging along and suddenly seeing a brilliant iridescent blue butterfly sailing across his path. It becomes the story of Ferdinand the Bull immediately.

Reduced and discouraged, the pirates sailed north again to the Bay of Panama, where Dampier and Wafer and some others decided to break away and recross the Isthmus to the Caribbean.

Dampier was now among the leading spirits, in spite of his dourness and inability to suffer fools gladly, and Wafer evidently admired and trusted him. And so, working to the north-east with the aid of a pocket compass, with the rainy season well advanced and a downpour every afternoon and night, their greatest hazard was the climate. Fortunately, Dampier had anticipated a wet trip, and "Foreseeing a necessity of wading through rivers frequently in our land-march, I took care before I left the ship to provide myself with a large joint of bamboo, which I stopped at both ends, closing it with wax, so as to keep out any water. In this preserved my journal and other writings from being wet, tho' I was often forced to swim." The day following, when they were trying to get their clothes and ammunition dried, Wafer was sitting on the ground next to one of the men who was drying gunpowder in a silver plate, when the powder exploded, and to quote Wafer himself, "scorched my knee to that degree that the bone was left bare, the flesh being torn away, and my thigh burnt for a great way above". Storms and floods were terrific and one man drowned in a mountain torrent, and not even Indians went abroad if they could help it. Yet Dampier, with the aid of Indian guides, went on, leaving Wafer and two others at a settlement of friendly Cuna Indians, and at last he reached the Caribbean, where he was fortunate in finding a French privateer who took the party aboard.

Eventually Wafer and his companions were able to march off into the tropical rain-forest, to discover just how wet a life on land could be—"the first three days we marched thro' nothing but swamps, having great rains, with much thunder and lightning; and lodged every night under the dropping trees upon the cold ground. The third night we lodged on a small hill, which by next morning was become an island, for those great rains had made such a flood that all the low land about it was covered deep with water. At this hill we remained the fourth day; and on the fifth, the waters being abated, we set forward, steering north by pocket compass. The sixth day,—we took up our lodging on a small hill where we gathered about a cart load of wood and made a fire, but not long after sunset it fell a raining as if heaven and earth would meet—thus it continued till 12 a clock at night; where to our great terror, we could hear the rivers roaring on both sides of us—which in less than half an hour carried away our fire. Running to save my life I met with a large cotton tree, having a hole in it about the height of four feet from the ground. I immediately got up into it as well as I could—and there sat down almost head and heels together—wishing for day. . . . I fell asleep, but was soon awakened by the noise of great trees which were brought down by the flood. When I awoke I found my knees in the water—and the water running as swift as if 'twere in the middle of the river. The night was still very dark, except when flashes of lightning came which made it so dreadful and terrible. While I was praying and meditating on my sad condition, I saw the morning star appear, by which I knew that day was at hand. This cheered my drooping spirits, and in less than an hour the day began to dawn, the rain and lightning ceased, and the waters abated, insomuch by the time the sun was up, the water was gone off from my tree. . . . Being frustrated of our design of going down the stream or of crossing either of these rivers—we were glad to think of returning back to the Indian settlement . . . this was the eighth day, and we had no sustenance beside the Maccaw-berries we had got, and the pith of a Bibby-tree."

So it was, starving and exhausted they staggered back to their starting point, to set out once again, only this time it was with a strong escort and a canoe.

Unlike Dampier, Wafer kept no journal, and his writings are from memory of his experiences, but they appear to be marvellously accurate and without exaggerations. His description of the plants and animals of the Cuna territory is good, but lacks the detailed interest shown by Dampier. He was not a naturalist and did not have Dampier's detachment, but for these very reasons he paid close attention to the people he lived among, and his account of them is meticulous and valuable. For they seem to be the most unsullied race on the Isthmus, akin to the Mayas of Yucatán. More than any other they have kept their racial purity, retreating to the mountain fortress before the Spanish penetrations, at times killing off groups of mixed descent, and in more recent times turning back surveyors for the Panama Canal. When the canal route was finally chosen along the line of the old Spanish highway from Porto Bello to Panama City—the trail Dampier and Wafer had taken on their outward journey—the Cunas were left in the isolation they so badly desired. Even today, foreigners who try to settle in their territory are inflexibly dislodged.

Albinos have always been cropping up among the population and were often killed at birth. Wafer wrote that the children of albinos were never white like their parents but were always copper coloured—"for so Lacenta told me, and gave me this as his conjecture how these came to be white, that 'twas through the force of the mother's imagination, looking on the moon at the time of conception; but this I leave others to judge of". If Wafer had lived in our time he would probably have been a travelling anthropologist with an interest in human genetics. I am sure he could have been a leading light in the American Museum of Natural History. Even in his own time he shows a healthy scepticism in pre-natal influence! Yet he takes the presence of the Cunas as much for granted as Dampier did his sloths and ant-eaters. Life simply exists where they find it. There is no thought of a past.

Cuna boys were raised to hunt with their fathers, girls were trained in the domestic arts, and the whole society appears simply organized but strict in its rules of behaviour, without superstitions. Marriages were arranged, a girl's parents picking out a likely boy. If the boy's parents agreed, he was put in a hammock with the girl for two nights, and the wedding followed. The only freedom left to the potential groom was to get out of the hammock, which brought no specific penalty but certainly made him generally so unpopular that most boys who did climb out prematurely left the community for good and frequently joined the ships of the buccaneers.

Following a wedding, which Wafer describes in detail, "All the men take up their axes, and run shouting and hollowing to a tract of woodland, which is before laid out for a plantation for the young couple. There they fall to work, cutting down the woods, and clearing the ground as fast as they can. This they continue about seven days, working with the greatest vigour imaginable, and all the ground which they clear, the women and children plant with maize, or whatever is agreeable to the season. They also build a house for the new-married couple to live in." This was followed by a regular house-warming, at the end of which most of the men were laid out cold by the amount of strong corn liquor they had swallowed. The women then put them all to bed in their hammocks and sprinkled cooling water on the bodies of their soused and snoring husbands.

The Cuna still live in tribal groups, often of several hundred, and when a man marries he becomes a member of his wife's family and subject to the ruling of the head of the house. But kindness and common sense prevail, and quarrelling within a clan-house is almost unknown; nor can secrets and intrigues arise.

Wafer thought the Cuna magicians "raised the devil", but in this he was far from the mark. For, while the Cuna seem to have a concept of a Creator God, it is one to whom no prayers are said, and who never intervenes in their everyday affairs. They have never built temples or altars to any deity, and make no supplications to any unseen powers. Perhaps their own existence is some proof that the meek shall inherit the earth, when you consider the fate of the Mayas and Aztecs to the north and the Incas to the south.

Eventually a chance came for Wafer to end his obligatory guesthood, for Lacenta and his dogs started up a peccary one day which got away from them after a long chase, leaving the chief in a towering rage. Wafer offered to make a quick trip to England to get some bigger and better dogs, and Lacenta allowed him, with his companions, to leave on condition that he return to marry his daughter. This condition was probably no more than ground bait, for of all peoples the Cuna have always prohibited intermarriages. So an escort took them to the coast, over the high eastern range—"over a ridge so narrow we had to straddle over on our britches"—and finally to the sea, where some French and English privateers lay off the mouth of the river. "We went aboard the English sloop, and our Indian friends with us, and were received with a very hearty welcome. The four Englishmen with me were immediately known and caressed by the ships crew; but I sat a while cringing on my hams among the Indians—painted as they were—red, yellow and blue, very bright and lovely"—all naked except about the waist, with a nose-piece of thin gold hanging over his mouth. " 'Twas the better part of an hour before one of the crew, looking more narrowly upon me, cried out—'Here's our doctor!' " That they found ships awaiting them was no more than good luck, though not too unexpected, since the Darien shore was generally frequented by the privateers, but that their own shipmates, Dampier included, should have been on board one of the vessels was almost unbelievable, for after Wafer had been left behind the others had gone on a buccaneering voyage all along the southern shore of the Caribbean.

11

THE SEVEN SEAS

THE FAMILIAR haven of Port Royal was closed and a hanging awaited any Porto Bello man who went back. Dampier, with other sea rovers, took refuge in Virginia, where fewer questions were asked, but after a year of the green flats and tobacco plantations, not to mention "troubles" which probably were charges of piracy, they were more than ready to go to sea again. When the chance came they jumped at it, and it arrived one April day in 1683 in the form of the *Revenge* with Wafer and others aboard, a Spanish ship taken by them from French buccaneers in the Caribbean.

A bold stroke was decided upon: to sail into the South Seas by a voyage round the Horn. John Cook, who brought the prize into the Chesapeake, commanded—Wafer went as surgeon—and Dampier in the lowly status of assistant to the navigator.

Dampier wrote that "we met nothing of importance till we came to the Islands of Cape Verde, excepting a terrible storm," while Wafer's journal omits entirely an account of the Atlantic passage. In fact both men were extremely and wisely non-committal when it came to reporting any acts of open piracy in which they or their ships were involved, and it is from the records kept by other members of the crew that we get the piratical flavour of the expedition.

For on nearing the Cape Verde Islands they robbed a Dutch ship of its wine, and finally after anchoring one night at the mouth of a river on the African coast, "a lovely ship" from Denmark appeared which they captured and renamed the *Batchelor's Delight*, and with another they had seized they were all set.

None of this appears in Dampier's journal, and he says only enough to account for his reaching the Cape Verde Islands—for what he found there interested him exceedingly. On one of the easternmost islands, barren, low-lying and treeless, called Salt Island because of its salt lagoons, he found a flock of red flamingos, and wrote: "When many are standing together by a pond half a mile distant, they appear like a brick wall, their feathers being of the colour of new red brick; and commonly stand upright and single, exactly in a row, close by each other. The young ones at first are a light gray; as their wing feathers spring out, they grow darker; and never come to their right colour or beautiful shape under ten or eleven months old. They build the nests in shallow ponds where there is much mud, which they scrape together making little hillocks, like small islands, appear out of the water, a foot and a half from the bottom. They make the foundation of these hillocks broad, tapering to the top where they leave a small hollow pit to lay their eggs in; and when they either lay their eggs or hatch them, they stand all the while, not on the hillock, but close by it with their legs on the ground and in the water, resting themselves against the hillock and covering the hollow nest upon it with their rumps. For their legs are very long, and building thus upon the ground, they could neither draw their legs conveniently into the nests, nor sit down upon them otherwise than by resting their whole bodies there, to the prejudice of their eggs or young, were it not for this admirable contrivance. They never lay more than two eggs, and seldom fewer. The young ones cannot fly till they are almost full grown, but they can run prodigiously fast."

Of all birds, the flamingos, or firebirds, evoke a recognition of beauty and interest in all who have seen them. Dampier was merely one of the first to write about them. The tragedy looming not too far ahead is that the ever-increasing pressures of human population destroy the inviolability of their sanctuaries. A thing of beauty may be a joy forever in the mind of a poet, but can it be a joy to anyone a few generations from now if such as the flamingo becomes no more than a few pictures on some ageing paper? It took the earth a good many millions of years to create them, and it seems that at the most a few centuries will suffice for their extinction.

They are as specialized as they are beautiful, and their beauty in no way mitigates the danger in an ever-changing world, in becoming perfectly suited to a particular way of life. It is the adaptable creatures that get along best when the world transforms the rats, the starlings and sparrows, and men. I wish they were better looking!

Flamingos feed only upon the small cerithium snails of shallow fresh water and brackish lakes, and from these molluscs they get their flaming colour. They can survive only where the snail itself succeeds in living in innumerable numbers, for the two are tied as closely as a sheep to grass. The long legs, the long neck, and the long overhanging upper bill all are designed for scooping the snails from the muddy floors of lakes and lagoons, the head swinging upside down in an arc towards the feet, shovelling below the water in its course. A screen along each edge of the bill allows mud and water to escape, while the minute snails pass into the long and sinuous throat.

The mud island nests serve to keep away egg-eating rodents and other menaces, but can themselves be washed quickly away by a storm or heavy rains. The conditions for survival are finely drawn. How the flamingo ever colonized isolated islands like the Cape Verde is itself something of a problem, for the cerithium snail is not marine. Possibly some adventurous flamingo transferred the snails in mud stuck to its feet, planting the seeds for future flamingo life, but fated to sow only for the sake of those to come. We shall never know. Yet in the end it is man who destroys the solitude, takes the eggs and drains the water, and the guilt belongs to us all.

From Cape Verde and the bulge of Africa the *Batchelor's Delight* set a course to the south-west, passing through the doldrums with the usual difficulty, and eventually making a landfall at the Falkland Islands in the South Atlantic, late in January, 1684. They found neither anchorage nor water, only "great shoals of small lobsters, which coloured the sea red in spots, for a mile in compass . . . no bigger than the top of a man's little finger". This was the krill, the teeming crustacean of those waters that sustains the great whalebone whales in their magnitude.

The ship missed the entrance of Magellan Strait, but entered the strait of Le Maire in the face of ferocious gales, and no sun was seen to rise or set from the time of leaving the Falklands until the storm-racked vessel sailed out into the Pacific Ocean.

Arrival at Juan Fernandez was a reunion, for three years earlier the sudden appearance of three Spanish ships of war had caused the buccaneers to slip their cable and put to sea. At the time one of their men, a Mosquito Indian, was hunting goats in the woods, and the ship was under sail before he came back to the shore. Now he was on the shore again, three years and three months later with some freshly killed goats dressed in tree-cabbage leaves, to welcome the new-comers. According to Dampier, three or four goats were first put on the island by Juan Fernandez during his voyage from Lima to Valdivia, and in almost no time the lush savannahs became stocked with large herds.

As soon as the boats from the *Batchelor's Delight* made shore, another Mosquito Indian, who had been on board, ran ahead, and the two expressed such a warmth of affection that even the buccaneers found themselves joining in the embraces. In the beginning the marooned man had with him his gun and a knife, and a small amount of powder and shot. When this was exhausted he converted his knife into a saw, and cut the barrel of his gun into small pieces, out of which he made harpoons, lances, hooks, and a long knife, heating the pieces first in a fire struck with his gun-flint, to make them workable. As Dampier says, "All this may seem strange to those that are not acquainted with the sagacity of the Indians; but it is no more than the Mosquito men are accustomed to in their own country."

He goes on to describe the island and island life, the land being for the most part vegetation and goats, and savannahs that he felt ought to support cattle and good crops of wheat, peas, yams, and potatoes. But in the sea "seals swarm as thick about this island as if they had no other place in the world to live in, for there is not a bay nor rock that one can get ashore on, but is full of them. Sea lions are here in great companies, and fish, particularly snappers and rock-fish, are so plentiful that two men in an hours time will take with hook and line as many as will serve one hundred men." The seals "have fine thick short fur, the like of which I have not taken notice of anywhere but in these seas. Here are always thousands, I might say possibly millions of them, either sitting on the bays, or going and coming in the sea round the island, which is covered with them, (as they lie on top of the water playing and sunning themselves) for a mile or two from the shore. When they come out of the sea they bleat like sheep for their young, and tho' they pass through hundreds of other's young ones, before they come to their own, yet they will not suffer any of them to suck.—The sea lion is a large creature about twelve or fourteen foot long, the biggest part of the body is as big as a bull, shaped like a seal but six times as big. The head is like a lion's head,—a broad face with many long hairs grownig about its lips like a cat. It has a great goggle eye, teeth three inches long, the bigness of a man's thumb; in Captain Sharp's time, some of our men made dice of them. They have no hair on their bodies like the seal, are of a dun colour, and all are extraordinary fat, one of them being cut up and boiled will yield a hogshead of oil. They grunt like swine, making a hideous noise."

Dampier's sea-lions are, after the sea-elephant, the largest of all the seals, while his seal is a fur seal closely akin to the famous herds of the Pribilof Islands. Since his time the vast numbers around Juan Fernandez have become reduced to mere remnants, for seal fur and oil have been coveted and taken for centuries. Few animals are more readily caught and killed than seals on land; and sealers and whalers have created more havoc on and about the sea islands than the buccaneers ever did, and in my opinion have in no way been any better, for both have shown greed without mercy, combined with the stupidity of ignorance.

The history of Guadalupe Island, two hundred miles off the coast of Lower California, shows the all-too-human touch. Early voyagers described it as a paradise, but some decades after Dampier's time goats introduced to provide a meat supply for whalers soon increased to over forty thousand. In a short time all the green, edible plant life was destroyed, trees had their branches and bark nibbled as high as standing goats could reach, and now nothing remains of an enchanting isle except barren and desolate ground deeply eroded into gullies. The shores are polished rocks, mute testimony to the basking, mating, and suckling of countless bodies of fur seals through the centuries before their sanctuary became known. Grass, trees, and birds have gone, and even the goats that wrought their destruction, together with a seal rookery that must have matched the fabulous colonies of the Pribilofs.

One bright spot alone stands out amid the wreckage. When animals are being slaughtered for profit, there is always the possibility that their pursuit will become unprofitable before complete extermination is accomplished, that the slaughter will end in the nick of time. In the case of the Guadalupe fur seal the end apparently came too late. It was thought, too, that the sea-elephants were gone for good. But about seventy years after their supposed extermination a small band was found and then lost once more. And then, about twenty years ago, several dozen of these two-ton, twelve-foot, blubber-wrapped beauties were discovered on one small beach. At the time of the final slaughter sufficient elephant seals must have been at sea or in caves to start the slow building of a new population, at the rate of one pup per cow each year. At least they had a better chance than the smaller fur seal of escaping their one enemy in the sea, the killer whale. For killers have enormous appetites, and one sixteen-foot killer whale when opened had had fourteen seals and thirteen porpoises for dinner. The sea-elephant is not so easily swallowed, and as a matter of fact doesn't do so badly itself. It feeds mostly on fish, with an occasional mouthful of seaweed to change the taste. One meal is known to have consisted of seven rat-fish, three skates, two sharks and four squids, mostly slow swimmers, although rat-fish never come closer to the surface than three hundred feet, and some items of sea-elephant food live twice as far down.

The credit for the slow recovery of the Guadalupe colony, after its own initial effort, belongs to the Mexican Government, which for the past twenty or thirty years has maintained an armed guard on the island with orders to shoot first and ask questions later. At the last accounting the herd had grown to fifteen hundred and has overflowed to the San Benito Islands and to the Channel Islands of California.

Whether the Guadalupe fur seal is gone beyond all possibility of recall is not entirely certain, for a few have been seen in recent years here and there not far from its old haunts. It is not altogether impossible that fur seals from other stocks may discover the island sanctuary anew, for there is so much concerning these mammalian mariners that we fail to understand. Above all, there is the question, how do they find their islands, for they only come to them for certain periods of the year in order to breed, and the rest of the time may be thousands of miles away. We naturally know most about the Pribilof herd, since it is the one great herd maintained and protected through man's enlightened self-interest. After all, fur is fur, and there is a lot to be said for a steady crop, and as long as the annual kill is restricted to the three-year-old bulls, with a percentage reserved for breeding, all will be well with the three-million herd.

Each spring the northern bulls push ahead to their ancestral home in the Bering Sea, picking strategic spots along the beaches. Later arrivals must take second-rate locations farther back from the sea. These are called the idle bulls, who have to wait till the beachmasters weary of mating, and behind the idle bulls are the surplus bulls and bachelors. The surplus bulls move up when opportunities come, but the bachelors are too young to mate.

For six to ten weeks the great bulls wait for the cows to arrive, not even daring to risk getting food, lest they lose their places. The females arrive close to midsummer, heavy with pup and just in time to give birth, usually within the first day or so after landing. Each first-rank bull gathers as many around him as he can, in the face of terrifying competition, and will collect anywhere from forty to one hundred docile little 90-pound ladies, all subdued by the presence of a 700-pound master. A six-year-old bull usually manages to start a harem of four, and it takes a ten-year-old to hold a hundred.

By August the harem masters are about ready to retire and go fishing. Then the two-year-old virgins arrive by the thousand, and the idle and surplus bulls flop down the beach to give them a joyous welcome.

After six or eight weeks the pups have learned to swim, and when three or four months old are driven by approaching winter into the open sea, ready to start the long migration south. The old bulls stay among the islands and brave the winter out, the younger bulls travel a little farther south, where killer whales make short work of about half of them. But the females may travel as much as six thousand miles each year, much of which is across the foggy, trackless North Pacific.

How they find their way I do not know. It seems to be much the same mystery as the means by which birds find their way on their long migrations. Moving south at the approach of winter and short days, to scatter over the wide belt of the Pacific Ocean from Japan to California, may not demand much in the way of navigation. But how do they keep a course for certain small islands, a spot location, in the far north, by night and by day, rain or shine? How well is it timed, do the pregnant females start at various times, depending upon where they happen to be, in order to land just when the pups are ready to be born, or can they hold their babies till it is safe to birth them? Above all, how do the returning virgins know the way when they are retracing, more or less, their steps for the first time? A fish has chemical senses that may enable it to tell one ocean current from another and find guiding signs within the sea itself. But a warm-blooded, hairy mammal, however aquatic it may have become, does its best not to sniff water and has no chemical detectors in its skin. Primarily it has sight and hearing to aid it in finding its way in space, and, of the two, only sight seems to be of any use under the circumstances. Do these migrating millions of oceanic mistresses orientate by vision alone, the sun by day and the stars by night, or is there some telepathic sense that tells them in what direction their lords and masters lie awaiting? A dog finding its way home eighteen hundred miles across a continent presents the same challenge. If telepathic communication between human beings really does exist, as the evidence seems to indicate, why should it not be better employed among those other mammals which have brains but which are not deafened by the sound of their own chattering language?

It is a queer business any way you look at it. Only recently, the large fur seal colony on the eastern coast of South Africa pulled up stakes, in the middle of the breeding season, and put out to sea, to go no one knows where, with newly born pups and untrained young left abandoned on the shore behind them. They have not been heard of since. Did some Pied Piper of the oceans call them to their doom, or have they found their way to some remote island in the west-wind drift?

Goat meat and green herbs put the scurvy-stricken buccaneers more or less back on their feet, and after a couple of weeks the *Batchelor's Delight* and its consort left Juan Fernandez and held a course with favourable winds for the Isle of Lobos, a few degrees south of the equator, keeping far enough off the coast of Chile and Peru to be safe from detection, but keeping the high blue ridges of the Andes within sight. As Dampier himself says, Lobos is merely the Spanish for seal, and seals and sea-lions there were, though not in the numbers he had seen at Juan Fernandez. The island was barren, without plants or water, though he found it covered with sea-fowl, some of which were boobies, but most were penguins.

While waiting at Lobos, cleaning ship and stocking up with sea-turtle caught by their Mosquito Indian fishermen, "one of our men being ashore betimes on the island, descried three sail to the north . . . we soon got up our anchors and chased". The ships were captured with little difficulty but were disappointing. "In the biggest ship was a letter to the President of Panama from the Vice-Roy of Lima, assuring him that there were enemies come into that sea, for which reason he had dispatched these three ships with flour, that they might not want, and desired him to be frugal with it. In this ship were likewise seven or eight tons of marmalade of quinces, and a stately mule sent to the President, and a very large image of the Virgin Mary in wood, carved and painted to adorn a new church in Panama." Flour and marmalade are all very well in reasonable quantity, but what these sea rovers had to say about a shipload, with a mule thrown in, I hate to imagine. To make matters worse, "she brought also from Lima 800,000 pieces of eight to carry with her to Panama; but while she lay at Guanchaco, taking in her flour, the merchants hearing of Captain Swan's being in Valdivia, ordered the money ashore again".

So in some disgust they sailed, taking the flour ships with them, from Lobos north-west for the Galapagos Islands, lying on the equator itself. Dampier speaks of them as lying "under" the equator, suggesting that the universe above his head was still the old circling spheres of Ptolemy. It may of course be no more than a manner of speaking, although the earth is not yet turning, except in the minds of a few, and it is doubtful whether Dampier in his pirate days was among those few. "When we came within 40 minutes of the Equator, we steered west, having the wind to the south,—the 31st day of May,—in the evening, the ship I was in . . . anchored on the east side of one of the eastermost islands, a mile from the shore, in sixteen fathom water, clean, white hard sand."

These islands are of perennial interest to naturalists, for Darwin was to make the most of them, as we shall see, and Dampier's description of them "lying under and on both sides of the equator", five to six hundred miles to the west of Peru, is remarkably informative. The easternmost islands were "rocky, barren and hilly, producing neither tree, herb, nor grass except a few Dildoe-trees by the seaside. The Dildoe-tree is a green prickly shrub that grows about ten or twelve feet high, without either leaf or fruit,—as big as a man's leg, from the root to the top, and is full of sharp prickles growing in thick rows from top to bottom." These are the great cacti of the dry South American coastal areas. Other islands to the west had groves of trees and small rivers, with "multitudes of Guanoes and Land-turtle or tortoise. I do believe there is no place in the world that is so plentiful stored with those animals. The Guanoes here are as fat and large as any I ever saw, and are so tame that a man may knock down twenty in an hours time with a club. The land-turtle are here so numerous that five or six hundred men might subsist on them alone for several months—one of the largest will weight 150 or 200 weight. . . . There are some green snakes on these islands, but no other land animal that I did ever see" and "there are good wide channels between these islands fit for ships to pass, and in some places shoal water where there grows plenty of turtle-grass; therefore these islands are plentifully stored with sea-turtle, of that sort which is called the Green Turtle.—This grass is different from Manatee-grass, for that is a small blade, but this is a quarter of an inch broad and six inches long." All this is typical of Dampier's outlook. He is intensely interested in everything he sees, but his attitude is simply that of a reporter, interested in a land-tortoise and a land-lizard, but taking it all for granted and as perfectly natural, with no sense of wonder concerning their presence on an isolated equatorial island.

After a week or two among the Galapagos the buccaneers stored flour on the island for future use: five thousand bags according to Dampier, fifteen hundred according to the navigator, and only five hundred according to Wafer. No wonder pirates were inclined to fall out over the division of spoils when arithmetic is of this quality.

From the Galapagos they sailed to Cocos Island, where they watered and laid in a store of fresh coconuts, and went on to the mainland, reasonably expecting to "have sailed with a flown sheet", yet "as we came nearer the shore, we found the wind right in our teeth.—but I shall refer my reader to the chapter on winds". Here lies Dampier's main interest, for in terms of a sailor and navigator he slowly evolves a global concept of the winds of the world.

At the Isle of Plata the ships were joined by others, and the small fleet sailed south again to make a typical buccaneering attack on the nearby mainland town of Guayaquil. The action is sheer melodrama. The company went ashore in canoes, into mangrove swamps not far from the town. As they struggled up the muddy creeks, far behind schedule, their ships fired cannon shot at some Spanish boats, making a noise that could be heard in the town and the leaders "being in the creeke when the guns fired, were ready to eat their guns for madd"! It was night before they managed to get past the belt of red mangroves on to higher land, and lights all over the town showed them they had been discovered. Yet they went on, with an Indian guide tied by a long cord to the leading buccaneer. "Yet this man notwithstanding his courage, privately cut the string that the guide was made fast with, and let him go to the town by himself, not caring to follow him; but when he thought the guide was got far enough from us, he cried out that the pilot was gone, and that somebody had cut the cord that tied him. This put every man in a moving posture to seek the Indian, but all in vain; and our consternation was great, being in the dark and among woods, so the design was wholly dashed, for not a man after that had the heart to speak of going farther." So they returned to the Island of Plata.

The rest of the story needs to be briefly told, for it would require a book in itself to do it justice. Two years later finds them still raiding up and down the western American coast, reinforced by buccaneers streaming over the old land route across the Isthmus, maintaining a reign of terror or sending intimidating threats ashore signed by "The Commanders of all the South Sea". During this period an amazing number of pirates, more than a thousand, gathered in the Pacific, and for a long time waited together to intercept the Spanish treasure fleet, finally to be disappointed, for the fleet, well warned in advance, had sailed far to the westward of their usual route near the Pearl Islands where the pirates had foregathered, had landed the gold, silver, and jewels, and had then come seeking the buccaneers, and it was the buccaneers who had to run.

At last it was decided to go home. The *Batchelor's Delight*, with Wafer aboard but without Dampier, sailed on a wild run through the South Pacific and around the Horn to Virginia. The commander was Davis, and they seem to have been the first white men to sight Easter Island, for a long time to be known only as Davis Land, an island of mystery from the beginning.

From the coast of Brazil, Davis navigated his ship to the Caribbean, and from there Wafer found passage to Pennsylvania and once again to Point Comfort in Virginia. "There I thought to settle," writes Wafer, "but meeting with some troubles, after a three years' residence there, I came to England in 1690." Times had changed in Virginia since he had last left it, and this time most of his stay in the colony was in the common jail of Jamestown, lucky to have avoided swinging at the end of a rope for piracy. In the end, Wafer and two companions were released; and in 1692 a royal order gave them back their Spanish gold, except for £300 together with a quarter of the amount left in Jamestown which was to be "applied to the building of a college in Virginia". This was built later on York River, and so it was that Lionel Wafer, surgeon-buccaneer, contributed to William and Mary College. The promotion of learning owes more, I believe, to the support of ill-gotten gains than most of us suspect, though conscience has played a greater role than retribution.

Dampier took the longer road back across the mid-Pacific, and came in the end to London, a year after Wafer's arrival in 1690, but only after three years of trouble in the East Indies. The commander of the ship he travelled on was Captain Swan, an unhappy trader turned pirate by force of circumstance, who crossed the Pacific hoping, with

Dampier, to have done with buccaneering and to get back to honest trading. They reached Mindanao in the Philippines and stayed there half a year, but the captain became tyrannical and stayed more and more on shore, until the crew mutinied and sailed off without him. Dampier's behaviour was typical, taking no part in the mutiny, nor doing anything to get the master back on board. Dampier turned pirate again for a year and a half, but, after a long illness in the Nicobar Islands, left the ship and made a year-long trading trip to Tonquin in Indo-China and wrote a book about it, thence to Malacca and Sumatra. Here he became virtually a prisoner as the master gunner under a ruffianly governor of the East India Company at Benkoelen. He succeeded finally in escaping after another year, and in getting passage to England on one of the company ships, "creeping through one of the port-holes of the fort, I got to the shore, where the ship's boat waited for me and carried me on board. I brought with me my journal and most of my written papers". And so, at very long last, Dampier saw the South Foreland of England in September, 1691, eight years after he sailed from the Capes of Virginia. What he brought back were drawings of sea-creatures, birds, and plants, mainly of the East Indies, a journal of peoples and customs throughout the maritime East, and above all his notes and understanding of the winds of the world—and the next few years were spent in London as an author seeing his books through the press.

There is an epilogue, It may not have been what Dampier would have wished, but it is in keeping, I feel, with the rest of the story, and it shows the man in again another role, and ends with a flourish that has come down through the centuries.

Dampier as a naturalist and fellow traveller of buccaneers was one man, in command of a ship he was another. As long as he had no responsibility he made the most of his opportunities, but with the necessity of making other men do his bidding, frustrations enraged him, and decisions once made were all too quickly changed—trouble succeeded trouble.

His first command took him to the barren west coast of Australia, and had his ship been better he might have anticipated Captain James Cook. As it was, a rotten ship and a sick and mutinous crew broke his spirit and he turned homeward, the crazy vessel getting as far as Ascension, where she foundered. From there he got passage on a man-of-war to the West Indies, and made the last lap home on a merchant-man.

In 1703 he sailed in command of the privateer *St. George*, accompanied by the *Cinque Ports* with Pickering as captain, Stradling as lieutenant, and Alexander Selkirk as sailing master, both ships being commissioned as warships. Dampier's mood was felt at once. At the Cape Verde Islands he forcibly dumped his first officer on shore after a quarrel and sailed on at once without any clear plans in mind. Off the coast of Brazil he got mad again, and his new first officer and eight of the crew left the ship and preferred a small island and probable capture to going any farther with Dampier. About this time Pickering died and Stradling took his place on the other ship, and after a stormy council the two ships went on to Juan Fernandez. Violent quarrelling broke out at the island, this time on the *Cinque Ports*, with Dampier surprisingly acting as peace-maker. A French ship came in sight, which they chased and lost, only to return to find two armed French whalers at the island already in possession of the gear and most of the men who had been ashore. Both Stradling and Dampier ran for it, but after a few months' raiding along the mainland coast, Stradling returned in the *Cinque Ports*, hoping to find the gear and crew, but all were gone except for two men who apparently had enjoyed the vacation. Selkirk and Stradling quarrelled this time and, influenced by the men now being picked up, Selkirk was marooned on the island at his own request, with all his belongings, rather than stay with Stradling any longer. A little later Dampier and Stradling had their turn at quarrelling, and parted company in the Bay of Panama. Dampier then quarrelled for the third time with his first officer, who left him with twenty-one men, followed shortly by another thirty-five. The *St. George* became unseaworthy, and with the remnant of his crew Dampier sailed a prize brigantine across the Pacific to the East Indies. On his arrival the Dutch considered him to be intruding and imprisoned him, and it was not until the end of 1707 that he once again succeeded in reaching England.

When he returned from this disastrous voyage, merchants of Bristol were already organizing a privateering expedition to the Pacific, with Woodes Rogers as captain. The post of pilot was offered to Dampier, and for once he went on a voyage which required all his special skills and none of the qualities he did not possess. The two vessels were the *Duke* and the *Dutchess*, and Dampier sailed on the *Duke* with Rogers, one of the most competent captains of the day. Many prizes were taken, and booty amounting to about £170,000, a large part of which went to Woodes Rogers, who was thus able to rent the Bahaman Islands and become their governor, for twenty-one years. But the most notable incident of the voyage was the rescue of Alexander Selkirk from Juan Fernandez, not altogether surprising, since Dampier knew he was there and knew only too well how to find that island.

Selkirk had had four years of more or less comfortable solitude, and had had more than enough, yet he went aboard the *Duke* only after he was assured that Dampier was not in command. He had no personal dislike of him, but in view of his knowledge of Dampier's former misconduct and irresolution, considered a stable island to be more secure than a ship under Dampier's command.

Reassured, he went aboard, and on Dampier's statement that he had been the best man on the *Cinque Ports*, Rogers made him the mate. And so Selkirk in his turn completed his voyage round the world, to inspire Defoe's Robinson Crusoe, and Stevenson's Ben Gunn in *Treasure Island*. The facts in detail, however, are much better than the fiction.

For forty years a travelling naturalist, hydrographer, and fighter, Dampier recalls the lines from "The Forsaken Merman": "There great whales come sailing by, sail and sail, with unshut eye, round the world for ever and aye."

12

WHERE THE WINDS BLOW

We move forward in time through sixty years. For most men and women it's a lifetime, which seems long or short, depending upon where you are along the road. To speak of the eighteenth century suggests a large chunk of history or a long period of time, yet Benjamin Franklin was born five years after it began, and could have heard of the rescue of Alexander Selkirk had it been properly publicized—and he died but ten years before its end. Newton put the cathedral of his thought upon the foundations of his predecessors before even the century dawned, and throughout Franklin's youth sunned himself in glory as president of the Royal Society and keeper of the Royal Mint. The great period of creative thinking passed its peak, for any extensive effort, whether of thought itself or of the colonization of new lands, requires time thereafter for consolidation and development. I do not mean that all was still, for the new concepts and ideas spread far and wide, and gradually the new universe took hold throughout the Western world. The earth was spinning on its axis, and with other planets wheeled around the sun—no longer news, though new to many. Franklin flew his kite and showed that lightning and man-made electricity were the same. The wonder grows, though the pace is slower, and in our year now of 1772 he had, like Newton before him, left his science to serve mainly as a statesman. He still dangled thermometers in the sea as he made his crossings to London, to chart the Gulf Stream by its temperature, but his mind was on the need of a General Congress of the American colonies for the defence of their constitutional rights. This is the time where our new journey starts.

Man's new outlook on the universe is not so different from the time of Dampier—what is different is the extent to which it is shared. I doubt if Dampier could have seen Newton's universe even had he tried, though he may have known the man. But now all the Western countries watch the sky with telescopes, and even to a sailor Venus is a planet and not a noble star, let alone a goddess. For the first time ships set sail for the sake of discovery alone, without thought or desire for plunder. The old mists are gone, for the light is stronger, and the vision is clearer. And we are given a marvellous picture of the world by a young man keyed to the fullness of life, educated in science and in tune with his time. He is modern man at his best, though born two centuries ago, and I know of no better reading than the twelve hundred pages that makes up Georg Forster's journal of *A Voyage Around the World.*

It is remarkable in many ways. The Forsters were a German family who had moved to London, and while the father was an eminent botanist, father and son eked out a precarious livelihood as translators. The break came when the older Forster was offered the chance to accompany Captain James Cook on his second voyage around the world, and fortunately son Georg, aged nineteen, was allowed to accompany him. I say fortunately because a publication contract prevented the father from publishing his own account, but his son's hands were free. Thus we can see the world of the late eighteenth century through the wonderfully clear eyes of a highly intelligent, highly educated youth, old enough to have both comprehension and sympathy, and young enough not to be stuffed full of blinding doctrines and the dry facts of information, young enough to have an open, though measuring, mind.

Here I cannot help but say something concerning our present educational circumstance, because Georg Forster illustrates what it is we now are and are not doing, and which we must do if we are to avoid bogging down in our journey into wonder. We are over-emphasizing the facts of life, we ladle them out from infancy through adolescence, we add four years of college and say to the victim, Now perhaps you should start to study the really exciting history of this science, but you must take more and more courses before you will be fit even to start a journey on your own. And the final product, probably approaching thirty, with a wife and child, is so loaded with detail and other men's thoughts that he can hardly waddle, let alone take flight. And the more we dig up new facts the more we pile them on, the more time it takes to adjust the load. This may seem somewhat off the track, but it is not, and in any case I am professionally a teacher, and this is a trend that has troubled me a lot. For, whatever else we may be doing, we are not extending the length of active life of the individual—a centenarian is no younger than he used to be. If we snatch thirty years out of the threescore and ten for preparation for the journey, we have overtrained our man, he starts too slowly and has no time to finish. We must find, as every generation must, a short cut to where we stand, and this is where we fail. A new runner should take but a few short steps before he snatches the torch to take his turn and run his course—at least, that has been the way of it. Now we make him run too long before we let him hold it. But Forster was nineteen when he started on his journey, and no more than twenty-three when he published his book.

I am speaking, of course, of the uncommon man, for it is he who wins a race, but at present he is handicapped like the rest; but young Forster was one who was not held back. He is a key figure, not only for his journal and the influence it may have had—and not because he succeeds Dampier as a naturalist visiting the Great South Sea. It is more direct than this, for he became eminent as a scientist; he became the personal guide and tutor of Alexander von Humboldt, the most illustrious figure of the first half of the nineteenth century; and Humboldt, through his writings, literally inspired Charles Darwin. There is no break in the chain, and between them, in their own way, they transformed our vision of the universe of life as completely as Copernicus, Galileo, and Newton changed the universe at large.

This time a ship, the *Resolution*, with the *Adventure* as consort, set out with "the greatest navigator of his time, two able astronomers, a man of science to study nature in all her recesses, and a painter to copy some of her most curious production"—such is the introduction Forster gives to his narrative. It was a scientific expedition primarily, in a ship that had all the sailing qualities of a haystack, mainly to probe the existence of a large southern continent.

The Forsters took coach from London and joined the *Resolution* at Plymouth, sailing one July morning through the quiet waters of the sound, past the new Eddystone Lighthouse, and out into the Channel, where the wind rose and even some of the most seasoned sailors suffered seasickness. Within a week they were off the coast of Spain, and near Corunna three Spanish men-of-war fired shot across their bows, making them heave to, and "after a scene so humiliating to the masters of the sea, we continued our course, and passed Cape Finisterre in the night. Several porpoises passed us, all swimming against the wind. At night the sea appeared luminous, particularly the tops of the waves and part of the ship's wake, which were illuminated by a mass of pure light; but independent of that, there appeared numerous little sparks infinitely brighter than any other part of this phenomenon." There was no thought that the light was an emanation of life itself, the living star-dust of the seas, though they must have wondered.

The ships touch at the Madeiras and go on to the Cape Verde Islands, and Forster confirms Richard Hawkins that flying fish fly in all directions and not only against the wind, and throughout the Torrid Zone finds daily wonder in continual drama of flying fishes escaping the jaws of bonitos and dolphins only to fall prey to boobies, men-of-war birds, and tropic birds. It is a thrill that all voyagers get when they cross the tropics for the first time, and I hope it never ceases.

At the Cape Verde "the captains, astronomers and masters spent this day in making astronomical observations", checking their new-fangled chronometers. The Forsters, being naturalists, watched kingfishers catching red-and-blue land-crabs, but, like others before them, found the islands unimpressive and were glad to set sail for the Cape of Good

Hope. The start was somewhat depressing, for one of the carpenters fell overboard and was drowned, and the young Forster's character comes out in his comments: "Humanity stole a tear from each feeling traveller, the tribute due to a rational fellow creature of a gentle and amiable disposition". Heavy rains fell soon after leaving the islands, much of which was collected in awnings spread to catch it, and Forster was again disturbed when a bedraggled swallow which he took care of finally fell victim to one of the ship's cats.

Days pass slowly during the long voyage across the waist of the world, and everything in the sea and air becomes a topic of wonder or admiration. Killer whales passed the ship on an opposite course. Man-of-war birds sailed overhead, although pilots no longer sent look-outs to the masthead in consequence, as Columbus did; Forster writes that "it is a common belief among sailors that their appearance denotes a vicinity of land; but we were at present above a hundred leagues from any shore, so that this opinion seems to have no better support than many old prejudices. Each eradication of one of these is a gain to science; and each vulgar opinion, proved to be erroneous, is an approximation to TRUTH, which alone is worthy of being recorded for the use of mankind."

Nearing the equator "a boat was this day hoisted out in order to find the direction of the current, and to determine the temperature of the sea-water at a great depth. We sounded with 250 fathoms without finding any bottom. The thermometer in the air stood at 75½ degrees, dipped under the surface of the sea it showed 74 degrees, and after being let down to the depth of 85 fathoms and hauled up again, it was fallen to 66 degrees. The boat being out, we had an opportunity of examining that kind of blubber, or sea-nettle, which Linnaeus has named *Medusa pelagica*; together with another submarine animal called *Doris laevis*, and employed ourselves in making drawings of them, and more minute descriptions than have hitherto been published." And so begins the serious study of the floating and drifting life of the oceans, with some actual oceanography.

The equator itself has become the imaginary line around the world, and no longer lies overhead in celestial grandeur, as it did in the day of Columbus, as the axis of a revolving sky. It is the earth now that turns, and its belt moves with it. And on September 9, "having passed the line with a light air, our crew ducked such of their shipmates as had never crossed it before, and did not care to redeem themselves by paying a certain forfeit of brandy". It was a day for a naturalist too, for apart from dolphins, flying fish, boobies, man-of-war birds, petrels, gulls, and tropic birds, "we had also at various intervals, found the sea covered with animals belonging to the class of Mollusca, one of which, of a blue colour, in shape like a snail, with four arms divided into many branches, was named Glaucus atlanticus; another, transparent like a crystal and often connected in a long string with individuals of the same species, was referred to the genus Dagysa—and Portuguese men of war (Medusa velella and Holothuria physalia) likewise appeared about our vessel in great abundance". Here are the jewels of the open seas, found everywhere between Cancer and Capricorn, far from the coasts of the continents. Only the first is a mollusc, in the narrower sense that we now use the word, and Forster's name has stuck. And it shows well what it means for a shell-protected sea-snail to leave the coastal sea-floor and take to the blue, wind-whipped waters a thousand miles from land. For a shell is heavy and is best thrown away, which Glaucus does almost at birth. A defenceless, drifting surface-animal of the tropical ocean had better be blue from above and as translucent as possible from below, to avoid discernment by the birds and fishes, and Glaucus is both. And it needs to stay near the surface, for there is only death in the depths, and that takes work, particularly in the warm, thin water of the tropics. So Glaucus reduces the work to the minimum by being as watery as possible and by exposing as much surface as possible, through its amazing body branches, to the water around it.

The string of jellies were neither molluscs nor jelly-fish, but salps, the peculiar, transparent, chain-growing, oceanic organisms surprisingly related, of all things, to fishes. Theirs is a fantastic story: chain salps break up and each grows an embryo which becomes a solitary salp that grows a long chain of two or three hundred egg-producing salps. When, later in Forster's lifetime, the poet Chamisso sailed around the world as a supercargo and described the life-history of the salps, he was simply disbelieved and thought to be conjuring up another of those fairy stories for which he was famous.

Yet of all the soft-bodied drifters of the seas, the "before-the-wind-sailors" have always caught the mariner's imagination the most. They are related to the jelly-fish and their kind, but are much more complexly constructed. And from a small sailing-ship the little velellas are entrancing, often covering the ocean as far as the eye can see, each a little blue-purple disk a couple of inches across, with myriads of small, anemone-like mouths hanging below, and a sail raised above the disk to catch the breeze, to go wherever the wind blows. Watching them you feel that the very light of the blue heaven itself is mirrored in their tissues and reflects back as pure as it entered.

The Portuguese man-of-war is a similar sort of sea surfacer, though larger, with a blimp-like sail cocked at an angle to the submerged body, dragging intensely stinging tentacles sometimes a hundred feet behind. The sail is a gas-filled float of a shining pinky-blue, and a ship may pass through these creatures for days on end. Why the sails are set crooked has long been a subject of wonder, for a physalia sailing straight before the wind would trail its blue fishing tentacles just as effectively as it does when sailing at an angle. Something of an answer has recently come to light, and we need to do little more than change the time and the name of the ship, keeping to the tropical Atlantic and the Portuguese man-of-war, but coming to the middle of the twentieth century on board the research ship *Atlantis*. From this another marine scientist has put two and two together, and the answer to the sail is found in the wind itself. It is a simple matter, but I believe it shows how closely interwoven the form of a living creature and the nature of its immediate universe can be, one is truly part of the other.

You need to see the wind, for wind that seems to drive straight across the land or sea does nothing of the kind, but blows like corkscrews, spiralling as it goes. And the wind-screws go in pairs, revolving toward each other. We would never know it, but mathematicians have deduced it, the soaring gulls and albatrosses show they feel it, and the windrows of weed and foam on the surface of the sea show its effects. For where the wind blows the water flows, and where there is an updraft the water converges and sinks beneath it. Whatever floats is caught there above the lines of sinking water, windrows of flotsam which are entangling death-traps to the sailors-before-the-wind.

So the physalias sail at a sharp angle to the wind, and have a good chance of cutting across a windrow of weeds, instead of taking the paths of the weeds themselves. But that isn't all of it, by a long way. If Forster had had more time to see and think about his men-of-war he might have noticed that north of the equator the physalias are right-handed, with the sail running from front right to rear left, while to the south they are left-handed, from front left to rear right. One is the mirror image of the other. And once again the answer lies in the wind and the currents, only the spin of the earth has a part to play as well. For the spinning earth swings the air and water one way in the Northern Hemisphere and the other in the Southern, and if physalias were all the same they would have trouble one side of the line or the other. Yet whether there are really two kinds of physalias is another matter, and it is doubtful whether the differences are due to heredity. I think it is more likely that there is an actual weeding out in each hemisphere of physalias with the wrong shape, that only right-handed sailors survive the weed-traps in the north and only left-handed in the south.

When the wind blows upon the shore, physalias by the thousand may find themselves stranded; but if you find them, don't touch their unhappy beauty, for they have a sting that can prostrate you; only if you have walked barefoot all your life and have soles half an inch thick can you step on one with impunity.

The long days passed slowly, the sea temperature dropped, the wind veered little by little, and the ships made their way to the south-east. Boobies and tropic birds disappeared and the sea-fowl of the cold south—albatrosses, shearwaters, gannets, and petrels of all kinds—took their place.

At the end of the month the cloud-capped Cape of Good Hope came in sight, and the *Resolution*, being far ahead, stood off and on in Table Bay all through a squally but never-to-be-forgotten night. "As far as we could see the whole ocean seemed to be in a blaze. Every breaking wave had its summit illuminated by a light similar to that of phosphorus, and the sides of the vessel, coming in contact with the sea, were strongly marked by a luminous line. Great bodies of light moved in the water along our side, sometimes slower, sometimes quicker; now in the same direction with our course, now flying off from it; sometimes we could clearly distinguish their shape to be that of fishes, which when they approached any smaller ones, forced these to hasten away from them. Desirous of enquiring into the cause of this astonishing phenomenon, we procured a bucket full of the illuminated sea-water. The most accurate attention to it proved, that innumerable minute sparks, of a round shape, communicated this luminous appearance to the water, and moved about in it with great briskness and velocity.—As I stirred the water with my hand, one of the luminous sparks adhered to my finger. We examined it by the common magnifier of Mr. Ramsden's improved microscope, and found it to be globular, transparent like a gelatinous substance, and somewhat brownish.—There was a singularity, and a grandeur in the display of this phenomenon, which could not fail of giving occupation to the mind, and striking it with a reverential awe, due to Omnipotence. The ocean covered to a great extent, with myriads of animalcules; these little beings, organized alive, endowed with locomotive powers, a quality of shining whenever they please, of illuminating every body with which they come in contact, and of laying aside their luminous appearance at pleasure; all these ideas crowded upon us, and bade us admire the Creator, even in his minutest works." And so, lost in wonder, the luminescence of the sea is recognized as a living emanation, and the scientific examination of microscopic ocean life begins. It has a fascination all its own, and I know of nothing to compare with the strange, transparent living shapes of the minute ocean-forms when you see them through a microscope. It never palls, and even now I would rather just look at them, completely fascinated, than see them as a scientist. I have known biologists, as eminent as they come, who have put aside regretfully their wonder and emotion at the beauty of these creatures and the way in which they grow, in the belief that it has no part in science, is irrelevant and distracting. I don't believe it. For the reality is the whole of life and not just what we choose to see.

After three weeks of Dutch hospitality, Cape wine, Hottentots, and experience of the amazing wealth of African quadrupeds, some of which, the rhinoceros and hippopotamus, were already subject to conservation restrictions, the journey continued, starting a voyage east around the world in high southern latitudes, probing for a rumoured polar continent. Two days out, "after a hard gale we caught nine white albatrosses with a line and hook, baited with a bit of sheep's skin. Several of them measured above ten feet from tip to tip, between the expanded wings".

Gale succeeded gale, the sea ran high and "the decks, and the floors of every cabin were continually wet; the howl of the storm in the rigging, the roar of the waves, added to the violent agitation of the vessel, which precluded almost every occupation, were new and awful scenes, but all the same severely felt, and highly disagreeable. The air was likewise unpleasantly sharp and cold". Forster reports that warm toddy was issued to everyone, and thick trousers; and that in common with everything the Navy provided, being supplied under contract, they were therefore generally too short. Modern times had arrived.

Temperatures continued to drop, petrels and terns increased in number the higher the sea and winds became, and a sooty albatross came to keep them company, too fresh a sight as yet to be a legend. Fresh water in the casks on deck began to freeze. Large icebergs drifted by, two thousand feet long and two hundred feet high, "at least as high again as our main-top-gallant-mast head". Bergs became ever more numerous, and in mid-December there was a cry of "Land to the south", bringing everyone on deck. No land, but the antarctic ice-pack lay before them, seen for the first time. "We saw an immense field of flat ice before us, broken into many small pieces on the edges, a vast number of islands of ice of all shapes and sizes rose beyond it as far as the eye could reach, and some of the most distant considerably raised by the hazy vapours which lay on the horizon, had indeed some appearance of mountains. Numbers of penguins, pintados, fulmars, snowy and blue petrels attended this vast extent of ice, and different species of cetaceous animals spouted up the water around us . . . we passed through quantities of broken ice in the afternoon, and saw another extensive ice-field, beyond which several of our people still persisted in taking fog banks for land. It snowed a good deal during the night, and in the morning it was almost calm, but very foggy.

"A boat was hoisted out to try the direction of the current. Mr. Wales the astronomer, and my father, took this opportunity to repeat the experiments on the temperature of the sea at a certain depth. The fog increased so much while they were thus engaged that they entirely lost sight of both ships. They rowed about for some time, making vain efforts to be heard, but all was silent about them, and they could not see the length of their boat." I imagine the sensation must have been like stepping through an unsubstantial mirror into another dimension, a feeling of bewitchment or bedevilment. "In this dreadful suspense they determined to lie still, hoping that, provided they preserved their places, the sloops would not drive out of sight, as it was calm. At last they heard the jingling of a bell at a distance—heavenly music to their ears—and returned on board, to their own damp beds and mouldering cabins upon which they now set a double value." You can still get a little of the feeling even on a modern liner, when fog rolls in and the ship slows or stops and there is no world left beyond your walls.

After several fruitless attempts to penetrate farther into the ice-pack, the ships stood to the eastward, making their way in hail and snow through broken ice. Christmas Day found them still among the icebergs, "and in the evening, the sun setting just behind one of them, tinged its edges with gold, and brought upon the whole mass a beautiful suffusion of purple—penguins skipped continually into and out of the water, making way with amazing velocity in a straight line". They caught one of the penguins and also a blue petrel, and Forster was amazed at the close packing of the feathers, the thick skin and layer of fat, of both birds, as protection against wet and cold. Petrels puzzled him, being so far from land, though, noting their long, strong wings, he wondered whether they might live over the whole ocean far from any land. Such reflections "afforded us a momentary relief from that gloomy uniformity with which we slowly passed dull hours, days, and months in this desolate part of the world—perpetually wrapped in thick fogs, beaten with showers of rain, sleet, hail and snow, the temperature of the air being constantly about the point of freezing in the height of summer, surrounded by innumerable islands of ice—and forced to live upon salt provisions". Even the keenest mind needs raw materials to reflect upon—perhaps because it is keen it needs it more, and Forster must have felt as though a book he was reading had been taken away just when he was getting into the story.

Great white whales came driving by; and penguins floated past, standing upright on small bits of ice. Three weeks after Christmas the ships crossed the Antarctic Circle and continued south to Latitude 67° 15′, the farthest south any man had been, "where many whales, snowy, grey, and antarctic petrels appeared on every quarter. An immense field of solid ice extended to the south as far as the eye could reach from the mast head." But no land in sight implied that there was no land, and there was no suspicion that the great bergs themselves were evidence of the continent they were searching for and whose existence they doubted, and this in spite of their knowledge that of the great masses seen above-water, nine times as much lay beneath the surface. Yet the latitude given for this turning point places them so close to the coast of Queen Maud Land of the antarctic continent that, given the right equipment, they could have walked ashore across the ice-field. So the *Resolution* and the *Adventure* were turned toward the north-east in an effort to locate the recently reported Kerguelen Islands close to the 50th parallel. Killer whales accompanied them, but the ice-floes and fogs were left behind as the wind rose and the gales of the roaring fifties took their place.

Shearwaters and seaweed suggested that land was near, certainly unreliable signs, as Columbus could have told them had he been around, but a smooth sea in the presence of an easterly gale was taken as an indication of land to the eastward. And though they failed to find it, they discovered later that they had been off the western end of the Kerguelens. Finding the islands would have given them about as cold comfort as they found in the icebergs to the south, though any land with grass, however bleak, treeless, and ice-capped, probably would have appeared in a rosy mantle.

The islands lie in the great ocean belt of the subantarctic, where most of the time the westerly winds roar around the world, driving the seas before them, with no continental shore to bar the way, the world of the winds and the wandering albatross. The wanderer carries a name that fits its greatness —*Diomedea exulans exulans*—and both the wanderer and the sooty breed in the lonely grandeur of the glacial islands, the Kerguelens and South Georgia, half the world apart.

I have never seen the wanderer, but those who have are lost in wonder when the great wings, eleven feet from tip to tip, bank against the rising air, and the bird, without quiver or beat, follows a ship for days on end. When banking on a sudden turn it often tilts ninety degrees to cut the water with the lower wing, for in the air it is the master of flight, with the greatest wings in the world. But, like the largest airplanes, the difficulties lie mainly in taking off, and an albatross sitting on the water fishing for squid or shrimp in calm weather will try to avoid a ship by swimming, and has actually allowed itself to be run down rather than try to take to the air. Even with a swell and rising air currents, an albatross may have to run along the surface of the sea for several hundred yards, hitting the water with its wings, before it succeeds in becoming airborne between one swell and the next. But in the belt of the antarctic west-wind drift the winds rarely cease their tumultuous rage, and the great wings are in their element, and the wind and the wanderer girdle the earth together.

Captain Cook failed to sight the Kerguelens himself, but he did put it beyond any doubt that the French discovery was a small island and not, as it was supposed at first to be, the north cape of a great southern continent. Heavy fog settled over the sea before the ships could depart from the neighbourhood, and they lost sight of one another. The guns were fired all day on the *Resolution* and flares burned all night, without answer, and so "we were obliged to proceed alone on a dismal course to the southward, and to expose ourselves once more to the dangers of that frozen climate, without the hope of being saved by our fellow-voyagers, in case of losing our own vessel". The cold southern ocean appeared drearily empty without the sight of the other sloop.

The journey continued, with petrels and albatrosses in constant company, and occasionally skuas, penguins, seals, and whales. At night great white columns of the southern lights shot up almost to the zenith and spread across the whole of the southern sky. In March they reached the 60th parallel again, but the lengthening nights, increasing cold, and signs of scurvy put a halt to the southern probing, and Cook turned the *Resolution* to the north and headed for New Zealand. They came to its southern capes within a week and entered Dusky Bay after a run of ten thousand miles out of sight of land, in one hundred twenty-two days from the

Cape of Good Hope. And a few weeks later, entering Queen Charlotte Sound, they found the *Adventure* and "those who have been in situations similar to ours, may form an adequate idea of the reciprocal pleasure which this meeting produced".

Throughout these journeys of Hawkins, Dampier, and Forster, I have been haunted by a feeling of familiarity, that I had been there before, and yet in plain sense I had not. But the feeling remained and in the end it was the albatross that brought it into focus. It is the *Rime of the Ancient Mariner*, in part at least. Listen to this:

> "The ship drove fast, loud roar'd the blast,
> And southward aye we fled.
> And now there came both mist and snow,
> And it grew wondrous cold:
> And ice, mast-high, came floating by,
> As green as emerald.
> And through the drifts the snowy cliffs
> Did send a dismal sheen:
> Nor shapes of men nor beasts we ken—
> The ice was all between.
> The ice was here, the ice was there,
> The ice was all around:
> It cracked and growl'd, and roar'd and howl'd,
> Like noises in a swound!
> At length did cross an Albatross,
> Through the fog it came;
> As if it had been a Christian soul,
> We hail'd it in God's name."

If this is not our voyage through the far southern ocean, I'll never read another book!

It becomes more than a hunch, when you really look into it. In *The Road to Xanadu* a fascinating inquiry into the nature of creative genius, centring around an analysis of Coleridge's other great poem, *Kubla Khan*, John Livingston Lowes shows how such gems are born. The steady accumulation within the mind of selected facts and images and ideas—note the word *selected*, for there *is* selection of the few from the many, though the sieve that sifts them out is not a rational one; all this comes first, and it is this that the imagination moulds to its will. Three creative factors come into play: the storing of the well with the chaos of facts, the vision that imposes the beauty of wholeness upon the pieces, and the will that shapes it for others to see. They operate not in poetry alone, but in some degree in all creative work.

And they apply to the creation of the *Ancient Mariner* even more than to *Kubla Khan.* Much more goes into its sinews and spirit than adventure into space, but we can see more clearly here, I think, some of the sources of the epic and what struck a poet's fancy, and what Coleridge read in his youth. When was his youth? Exactly at the right time to be reading Forster's journal, for he was born in the year the expedition set sail, and if I find it entrancing nearly two centuries later, imagine its impact when it was new—I was going to say "fresh", but that is something it can never lose. So Coleridge read Forster when he was most impressionable, we know he read Dampier and was in sympathy with his nature, and if we turn once more to the *Mariner* we find the Elizabethan too. Even more than this, we find the essence of creation itself, for he brings together in lovely lines the writhing serpentine corruptions Richard Hawkins saw near the Azores and the phosphorescence the Forsters saw in the sea off the Cape of Good Hope:

> "Beyond the shadow of the ship,
> I watch'd the water-snakes:
> They moved in tracks of shining white,
> And when they rear'd, the elfish light
> Fell off in hoary flakes.
> Within the shadow of the ship
> I watch'd their rich attire:
> Blue, glossy green, and velvet black,
> They coil'd and swam; and every track
> Was a flash of golden fire."

13

VENUS OBSERVED

THE SOUTHERN summer was past when the *Resolution* sailed into New Zealand waters, but through April into May the Forsters collected plants, filled their note-books, and watched and wondered. The majestic mountains capped with clouds and perpetual snow, the luxuriant woods and tree-ferns were as pleasing then as we find them now, but the Maoris seem to have spoiled their pleasure in the somewhat chilly paradise. Cold rain dampened action and enthusiasm, for winter was coming, and the compliment finally paid was grudging—"with all its defects, Dusky Bay is one of the finest places in New Zealand, for a set of people to touch at in our situation, exhausted with the labours and hardships of long continuance and deprived of land above four months". They found the sweet potato under native cultivation, felt an earthquake tremor and deduced volcanic action elsewhere, and wondered at the near-absence of quadrupeds. Only native dogs, rats, bats, and sea-lions were to be seen, and of these they thought the dog and rat might have been brought by men. The younger Forster writes of a kind of large rail. It may have been the kiwi, in which case he was the first to report the wingless, flightless birds of these large and far-isolated islands. Or it may really have been a flightless rail; for New Zealand, past and present, seems to be the home of large birds that cannot fly, rails included.

Symptoms of scurvy disappeared, but it was no time to return to the exploration of the high latitudes, with the dark and bitter antarctic winter already on its way. So we find ourselves sailing on a voyage among the tropical oceanic islands, to fill in time, store up with provisions, and fully re-establish the health of the crew. The ships go to Tahiti, to the Society and the Friendly Isles, for the most part a return visit as far as Cook was concerned. Tahiti meant, among other things, fresh roast pork, at least for the officers and scientists. Cook recognized that the Tahitian hogs were very different from those he knew at home, and thought they were very much like the Chinese variety, which shows something of his acumen, for we have reason to believe that the hogs the Polynesians took with them on their migratory voyages came originally from South-east Asia.

Then the spectre of venereal disease raised its head, and Forster is as dispassionate in his discussion of it as any present-day health officer, with the most concern as to who started it. For on the way to Tahati "the weather being mild and the wind very moderate Captain Furneaux of the *Adventure* came on board and dined with us. He acquainted Captain Cook that all his people continued in good health, except one or two, who were infected with a nauseous disease, which is propagated by connections with the other sex. This information gave us great uneasiness, it being evident that the distemper had already reached New Zealand, since our men must have received it there. Struck with the horrid consequences which this evil would entail on the New Zealanders, we recapitulated the opportunities which these people had of catching the infection from Europeans. The first discoverer of this country, in 1642, Abel Janszoon Tasman, had not the least amicable intercourse with the inhabitants, and none of his people appear to have been ashore upon it. Captain Cook, the next navigator who visited it in the *Endeavour* Bark, 1769 and 1770, came from O-Taheitee and the Society Isles, where several of his people had contracted venereal complaints. However, as his passage lasted nearly two months, the surgeon reported, when they made the coast, that no man had any symptoms of the distemper about him. Notwithstanding this assurance Captain Cook had the precaution, not to suffer any person to go on shore who had been under cure, and might be suspected to have some latent remains of this infectious evil; and to preclude the possibility of communicating it to a guiltless people, he never suffered any woman to come on board. . . . Our two sloops . . . had left the Cape of Good Hope, the last place where it is possible the sailors might contract this disorder, six months before they came to Queen Charlotte's Sound, five of which they had been at sea. We therefore concluded that . . . the venereal disease was indigenous to New Zealand and not imparted by Europeans. But if, in spite of appearances, our conclusions should prove erroneous, it is another crime added to the score of civilized nations, which must make their memory execrated by the unhappy people, whom they have poisoned. . . . A race of men, who amidst all their savage roughness, their fiery temper, and cruel customs, are brave, generous, hospitable, and incapable of deceiving, are justly to be pitied, that love, the source of their sweetest and happiest feelings, is converted into the origin of the most dreadful scourge of life." It is a remarkable summing up for a youth in the eighteenth century who has not yet reached his majority. I think what is a little startling is the capacity to look clearly and steadily at anything that exists or takes place and to contemplate it with the same unembarrassed directness as the Greeks used to do.

Four years earlier Cook had been in Tahiti, where the same situation arose, one of his men contracting the disease within a few days of going ashore, and more than half his crew being afflicted by the time he left. And in his own journal of that visit he speculates in much the same way as Forster does here (1769): "As it is certain that no European vessel besides our own, except the *Dolphin*, and the two that were under the command of Capt. Bougainville, ever visited this island, it must have been brought by one of them or by us. That it was not brought by the *Dolphin*, Captain Wallis has demonstrated in the account of her voyage, and nothing is more certain than that when we arrived, it had made most dreadful ravages on the island,—and by enquiries among the natives, we learnt, when we came to understand a little of their language, that it had been brought by the vessels which had been there about fifteen months before, and had lain on the east side of the island." Which left the responsibility squarely with the Frenchmen, exonerated the equally unhesitating English sailors, and made little difference to the Polynesians, who could hardly have been much interested in what particular variety of European brought the white man's plagues to their beloved islands.

I imagine Cook's earlier visit must have been the topic of much talk as the ships moved steadily into the warmer waters of the tropics and the fair trade winds replaced the cold wind and rain of the land and seas behind them. Above all, it was a story of a clock and a planet, for the new universe was generally accepted and the need now was to start measuring it. And so Cook, with naturalists Sir Joseph Banks and Dr. Solander, and Mr. Green the astronomer, had arrived off Tahiti in the *Endeavour* and set up their tent and their equipment at Point Venus. It is the sort of thing that has been going on ever since, and so have the anxieties that go with it. All night long before the transit of Venus across the sun was to take place they were up and down watching the sky for haze or clouds, fearful lest a little climatic indifference frustrate the whole purpose of the expedition. Natives had already stolen the vital quadrant, and only Banks's tactful pursuit brought it back from the interior of the island. But, as day broke, the sun rose without a cloud, the observatory was in order, and the telescopes were all fixed and tried. They were checking Newton's universe with the telescopes of Galileo. During the transit they saw an atmosphere around the body of Venus and measured the time it took for the planet to pass across the face of the sun. Space, I think, became real and measurable in that moment, and we took our first step on the journey into infinity, for men were not here to help navigation but to promote astronomy; the information was not for determining longitude but for use in estimating the distance of the sun—which brings us to the clock.

The clock is famous—possibly the most famous of all—and it is still keeping good time in the offices of the Royal Society of London, its original owner. The chronometers on the *Resolution* were successors made specifically for continuous operation on board ship, but the one taken on the *Endeavour* to Tahiti was used only on land, and looked like a typical grandfather clock with a long gridiron pendulum. Its history began in 1760, when the Royal Society purchased it from its maker, John Shelton (who was born before Dampier sailed to rescue Alexander Selkirk), and the following year sent it on an expedition to the South Atlantic to determine, among other things, the force of gravity both on the island of St. Helena and on the African continent at the Cape of Good Hope. Its pendulum swung seconds, and gravity was measured by the rate at which the length of the swing got shortened.

It was too good a thing to be kept idle, and before Cook took the clock to Tahiti it travelled across the Atlantic in 1765 to Messrs. Mason and Dixon, who were proposing to measure a degree of latitude and a degree of longitude in the neighbourhood of Pennsylvania. The ship carrying it was wrecked, but the clock was virtually undamaged, and Mason and Dixon made the survey that lives on as Mason and Dixon's line.

The Society sent a recall in 1767, in order to have the clock put thoroughly in order in time for the Tahiti observation of the transit of Venus, and it was carried by four men to Wilmington and thence by water to Philadelphia, to arrive in London late that year. On July 21, 1768, Cook and Green signed for "An Astronomical Clock, an Alarm Clock, A Journeyman Clock . . ." You can judge the importance of the occasion, for it was the first clock that could be used for the purpose, and it was the last transit of Venus that would take place within the lifetime of the men who were interested. Long after Cook's voyages and death the clock went with Parry, in 1819, on a voyage for the discovery of the North-west Passage.

When Forster first sees Tahiti it is more through the eyes of a poet than those of a navigator or of a scientist, and at last "in the evening, about sunset, we plainly saw the mountains of that desirable land, lying before us, half emerging from the gilded clouds on the horizon . . . we stood on towards this island all night . . . and at dawn it was one of those beautiful mornings which the poets of all nations have attempted to describe, when we saw the isle of O-Taheite, within two miles of us. The east-wind which had carried us so far, was entirely vanished, and a faint breeze only wafted a delicious perfume from the land, and curled the surface of the sea. The mountains, clothed with forests, rose majestic in various spiry forms, on which we already perceived the light of the rising sun . . . at their foot lay the plain, crowned with its fertile bread-fruit trees, over which rose innumerable palms, the princes of the grove. Here every thing seemed as yet asleep, the morning scarce dawned, and a peaceful shade rested on the landscape. We discerned however, a number of houses among the trees, and many canoes hauled up along the sandy beaches. About half a mile from the shore a ledge of rocks level with the water extended parallel to the land, on which the surf broke, leaving a smooth and secure harbour within. . . . The whole called to our mind the description of Calypso's enchanted island." Thus they entered the lagoon within the coral barrier and were welcomed by the waking Tahitians coming out in their canoes.

The island was a tropical paradise, the more so then than it is now, and breadfruit, yams, coconuts, and bananas were a welcome change from worm-eaten biscuit. After a while the two captains went ashore to visit O-Aheatu, the man they thought to be king, on their way passing a terraced pyramid about twenty paces long, more or less in ruins and overgrown with grass and shrubs. Cook had seen something like it on his first visit, but of a more impressive size. This was a pyramid also, close to burial-grounds, and one that had a rectangular base two hundred and sixty-seven feet by eighty-seven, and steps on all sides rising to a height of between forty and fifty feet. The coral blocks that made it were perfectly shaped and fitted and polished, while on the top of the ridge stood a wooden image of a bird and a broken stone carving of a fish. The whole formed one side of a large square paved with stones. In both cases neglect was evident.

There is so much plagiarism in the world that I suppose it is difficult to believe that men can dream the same things or build the same things independently of one another. Pyramids suggested Egypt, and the finding of pyramids of various types throughout Polynesia and Central America has led people ever since to see Egypt's influence spreading throughout the world by some sort of human contact. And for a long time the pyramids of Tahiti were thought to be ancient relics of a lost culture. Yet in truth, which is surprising, the largest had been built no more than two years before Cook saw it, and tropical vegetation and tropical human indolence gave an impression of abandonment.

Forster became especially entranced with the beauty of the land, its green abundance, the brightly coloured birds, the native dwellings with their plantations of sugar-cane, yams, sweet potatoes, and lily roots, the groves of breadfruit and banana, paper mulberry and coconut, and above all with the gracious charm of the Tahitians themselves. Hogs, dogs, and rats were the only quadrupeds to be seen. Everything and everyone seemed wonderful until he came across one of the petty chiefs whose "countenance was the picture of phlegmatic insensibility, and seemed to witness that all his thoughts centred in the care of his paunch".

Yet "the evident distinction of ranks which subsists at Taheitee, does not materially affect the felicity of the nation, as we might have supposed. Under one general sovereign, the people are distinguished into classes of aree, manahouna, and tow-tow, which bear some resemblance to those of the feudal system of Europe. The simplicity of their whole life contributes to soften these distinctions, and to reduce them to a level." O-Aheatu, little more than a youth, soon got over his initial distrust of the white men, and we find Forster speaking of him thereafter as O-Too. Then one morning Cook, the two Forsters, and some others rowed ashore from the *Resolution* to visit O-Too in an effort to recover the captain's bedclothes, which had disappeared the night before during a party held on board; probably it was a case of simple theft, but it would be a nice peg on which to hang a little fiction. As they approached the shore they beheld "one of the most magnificent sights which it is possible to be entertained with in the South Seas". The great war fleet of Tahiti, seen in all its magnificence possibly for the first and last time by white men—for Tahiti was in its finest flower and would never blossom so fully again. It is worth describing, including an incident of seeming unimportance.

"This was a very numerous fleet of great war canoes, lying arranged along the shore, completely fitted out, and manned with rowers and warriors, dressed in their robes, targets, and towering helmets. The shores were lined with crowds of people, and a kind of solemn silence prevailed among them. We landed and were met by Tee, one of the king's uncles, who was going to lead Captain Cook into the country, when the Commander-in-chief of the fleet stepped on shore and met them. At sight of him the common people exclaimed 'Towhah is coming!' and made room for him with a degree of veneration which surprised us. The chief advanced to Captain Cook, and taking him by the hand, called him his friend, and desired him to step into his canoe. It appeared to us at the time that Tee was uneasy, and did not approve of Captain Cook's going with Towhah; therefore, when we were just abreast of his canoe, which was one of the largest, the Captain stopped short and refused to go on board. Towhah left him very coolly, and, to all appearance hurt at the refusal, stepped into one of the canoes"—a slight misunderstanding, but one which sealed the fate of a nation. For there was no king nor sovereign lord of Tahiti. Cook and subsequent Europeans found O-Too because his territory had the best harbour, and every ship left him with a little more of white men's weapons. Tahiti was a federation of regional territories, each with its chief, and there was a well-working balance of power with no one man able to dominate the rest. O-Too was one of the less important ones, and it was a pity Cook did not recognize Towhah for what he was, the most respected and powerful of the Tahitians, and it was no wonder Tee and O-Too looked worried when they thought Cook was going to leave them. Had he done so he would probably have discovered the true state of affairs and seen O-Too in his proper perspective. As it was, O-Too slowly accumulated arms denied to the other chiefs, and as the weapons grew, so did his ideas. Fifteen years after Cook's visit the climax came. The mutineers from the *Bounty* landed at Tahiti, as usual in O-Too's backyard, and with their fighting power and his own accumulation of arms, O-Too subversively overthrew most of the other Tahitian chieftains, better men than he, but without a chance with their own native equipment. And so in all innocence Cook shook the foundations of the Tahitian society, for with O-Too's ascendancy it fell apart—morals and politics degenerated. Otherwise Tahiti might have maintained as vigorous and healthy a native community as the Samoan Islands to the west. And when a little mistake like this can put in chain such a sequence, I suggest that we are whistling in the dark when we talk of controlling our own human destiny. We influence it all the time, but we are dealing, I think, with something more masterful than ourselves.

Forster continues: "We counted no less than one hundred and fifty-nine great double war-canoes, from fifty to ninety feet long betwixt stem and stern . . . besides the vessels of war we counted seventy smaller canoes without the ranks, most of which were double likewise, with a roof on the stem, as victuallers to the fleet. There could not be less than fifteen hundred warriors, and four thousand rowers, besides those in the provision boats, and the prodigious crowds on shore."

Ships have always intrigued me, ever since I used to pass them in the heart of Bristol City, on the river down which John Cabot departed. And these canoes were no less than the kind employed to cross thousands of miles of the open Pacific when occasion demanded. Forster was lost in wonder at the way in which they were made: ". . . when we consider the imperfect tools—with which they have cut down huge trees, dubbed the plank, made them perfectly smooth, and at last brought these unwieldly vessels to the great degree of perfection in which we saw them. An adze of stone, a chisel, and a piece of coral are their tools, to which they add the rough skin of a ray, with which they smooth or polish their timber. All these canoes are double, that is, two joined together, side by side, by fifteen or eighteen strong timbers twelve to four and twenty feet in length and about three and a half asunder. When they are so long, they make a platform fifty, sixty, or seventy feet in length. The heads and sterns were raised several feet out of the water which stood up like long beaks sometimes twenty feet high, and were cut into various shapes. A white piece of cloth was stretched between the two beaks of each double canoe, and the wind swelled it out like a sail." One double canoe had no fewer than one hundred and forty-four paddlers, besides four men in each stern to steer them.

Warriors, with fantastic high headgear, stood on fighting platforms, and the whole fleet, of which this was but one of many districts, was assembling in order to subdue a rebellious people on a neighbouring island, but the *Resolution* could not wait to see the outcome, and departed for the rest of the Society Isles and to go on to Samoa. They found there the same benevolent people and lovely lands they had enjoyed in Tahiti, stayed for a while, and returned at last to New Zealand, taking a great sweeping course that brought them to islands of the New Hebrides and New Caledonia on the way. Among these they met only the small Negroid people, Melanesians with dark skin and frizzy hair, blow-pipes and bows and arrows. Finally New Zealand welcomed them with "repeated showers and chilling squalls of wind", but this time, possibly in contrast to the Negritos they had just left, the Polynesian Maoris appealed to them as a fine race of people.

To round off this South Sea circuit there is a curious side-light on cannibalism. Forster and some seamen came across a couple of Maoris ending a ceremonial cannibalistic meal of a slain enemy, and were invited to partake. The seamen recoiled in horror and wanted to slay the cannibals, but Forster, with surprising insight, especially for the period, realized the religious significance contained in the action and the gesture, that it is the vigour of the slain man's spirit which is being consumed with his flesh and that the men before him were of better moral stature than his companions. I do not mean to imply that he condoned the custom, but he did recognize the simple sincerity of the Maoris. Perhaps an incident which occurred on one of the islands of the New Hebrides chastened him a little, for he was among some white men who were finishing up a roast pig when some native Melanesians chanced upon them. And this time it was the dark-skinned tribe that recoiled, thinking they in turn had stumbled upon a group of cannibals. No mammals lived upon their island except human beings, and large bones could only be human, and seeing was believing. And as these journeys show, there's more to seeing than sight.

14

VIKINGS OF THE SUNRISE

A CORAL ISLAND in a blue lagoon fringed with the white of reef-broken surf, with warm-skinned, warm-hearted, brown-eyed maidens strolling on the sand in the shade of coconut palms, with scarlet hibiscus in their hair, is almost synonymous with modern man's idea of escape from a madding world. Take away the maid—or her man, for that matter—and the island becomes empty, no longer friendly, and its loveliness as impersonal as a painted scene. Substitute short, frizzy-haired, dark folk with blow-pipes and poisoned arrows, and the island becomes theirs alone, not yours at all. Why does it make a difference? Who are these charming, gracious people of the scattered islands of the mid-Pacific, and from where have they come? I have often wondered, and so, it seems, have many other men; for they have come up with answers all the way from Persia to Peru.

We do not feel surprise at finding primitive Negrito tribes far flung through south Asia and its islands, for their antiquity is all too obvious, but Polynesians look like sun-tanned Caucasians, and are handsome in our eyes like so many of the people of India and Indonesia. We recognize our own brotherhood, and I think it is this feeling of recognition of what we might have been that makes the thought of the South Sea Isles so appealing. The setting is paradise and the people are ourselves, only happier and browner! So we took them gifts of disease, commercial exploitation to the point of enslavement, and called them naked heathen!

There are many pieces to the puzzle, many we have and many are missing, and one picture overlays another. Young Norwegians sailed on the *Kon-Tiki* to show that a Peruvian raft could drift west with the south equatorial current to reach the Tuamotus, and to show that an island a mile off their course might be a thousand miles away if the wind or current swerved. Others trace the slow movement of a people east across a continent and an ocean, and one of these is himself a Polynesian, Te Rangi Hiroa, whose *Vikings of the Sunrise* is the title of his book and this story.

Te Rangi Hiroa is also Peter Buck, a New Zealander born of a Maori tribal princess and an Irish father, knighted by England, a doctor of medicine and science who commanded the hard-fighting Maori battalion in World War I, once a member of the New Zealand Government, director of the Bishop Ethnographic Museum in Honolulu, and a professor of anthropology of Yale University. While writing this I read the notice of his death, and the tense should have been put in the past. But a man so vital and recently alive has not died in any real sense, and I cannot do it. He leaves a monument to his mother's race in *The Coming of the Maori*, and alone has seen the Polynesian question from within and without.

The story as it emerges is of one of the greatest journeys of all time, of the making of a race with a place in the sun, with all that that implies. Everything that the Polynesian is, says, and does points backwards along his path in space and time, and in the beginning we see the shadowy figures of a forgotten people moving along the Iranian hills, through forests, across plains and rivers, passing along the Asiatic corridor from the Caucasus to Malaysia. This was long ago, and we can go back even more than two thousand years to discover the Polynesians already made, though not in the Pacific.

What went on in Malaysia to make the uniform racial type that we call Polynesian, where did the different strains that went into the melting-pot come from, and what path did the race finally take? For anthropometric measurements show that, while the natives of the Polynesian islands have migrated there at different times, they have all come from a common people somewhere outside present Polynesia, yet from a people undoubtedly of a mixed origin. It is not unlike the making of a cake: what goes into the dough shows up in the baking.

Stated briefly, the basic types continually cropping up among the Polynesians are broad-headed and long-headed. This is over-simplifying the situation, but where a race has arisen from a combination of originally different types, the population continues to produce individuals of a wide range of characters, whereas a purer stock does not. So that the biological problem is that we must seek a land to the west where a mixing of long-headed and broad-headed peoples could produce the hybrid ancestors of the Polynesians. All in all, south-east Asia seems to be the most likely area, and Indonesia in particular.

We start with the evidence that this territory was originally inhabited by Negrito-pygmies and Vedda-like aborigines. Where these came from is not the Polynesian problem, but one of the ancient beginnings of mankind itself. At some time in the past other types filtered slowly into the region, somewhat like the present Malayans, but more stocky, with longer heads and broader noses, and including individuals with some Caucasian blood. In the Malay Peninsula and nearby Indonesian islands they absorbed the Negritos and Veddas, and then moved on to the north and east. Some of this mixture was left along the trail they travelled and can still be found among the hills of Assam, Burma, and along the Tibetan borders, all in remote asylums.

Then came invasions by broad-headed Mongolian-type races, not in large waves, but as a steady infiltration. A mass invasion might have exterminated the southerners, but the new-comers were the ones absorbed, with the result that they lost their own language and adopted the Malayo-Polynesian speech, though they added some Mongoloid blood and character to the mixture.

This was only the beginning of the pressure from the north, and the people we must call the proto-Malayans came to a parting of the ways. Those who stayed became more and more mixed with the southern Mongolian race and became the broad-headed Malays. Others moved out as the pressure increased, some to northern Luzon and others to the east. Those who went east were the first Polynesians, and more were to follow.

Life in Indonesia encouraged the making and use of canoes, otherwise emigration by sea would hardly have been possible. When the time came they had a choice of two routes: a course curving a little northward into the multitude of the small islands of Micronesia, the Carolines, Marshalls, and Gilberts, or a more direct route through Melanesia among the larger islands of New Guinea, the Solomon, and the Fiji Islands. There has been some argument concerning which path was taken, but taken as a whole the evidence favours the northern route.

The most direct evidence comes from the study of the blood of Polynesians and Melanesians by Dr. Shapiro of the American Museum of Natural History. Four human blood types are recognized: O, A, B, and AB. Polynesians have O and A in varying percentages. B is absent in the islands of the eastern fringe such as the Tuamotus, Australs, Marquesas, and Easter Island, although there is a slight trace of it in New Zealand, Tahiti, and Hawaii, a trace which may well be the result of mixing with foreign white blood. It seems most unlikely that B blood was present among Polynesians when they first entered the Pacific. On the other hand, B type blood is present in Melanesia and increases as we move west into the bigger islands. It seems, then, that the Polynesians must have avoided Melanesia and swung to the north into the small uninhabited islands of Micronesia, for there is no doubt the voyagers spent several generations in passing through the islands, and had they rested in Melanesia they would have carried along with them a legacy of some Melanesian B blood all the way to the eastern Pacific. The present Mongoloid inhabitants of the Micronesian islands arrived there in more recent times and are not part of the story.

The fact that B type blood is found in a fairly high percentage in western Polynesia, in Samoa and Tonga in particular, and that Polynesian language and some customs and physical characteristics occur among islands of eastern marginal Melanesia, are evidence of later contacts between the two groups of people. They do not fit the pattern of a Polynesian exodus through Melanesia.

Actually there were two drives to the east, with a long interval of centuries between. The vanguard escaped with little Mongolian mixture and broke through into central Polynesia without further contacts. The rearguard lingered long enough in Indonesia to absorb many more of the Mongolian new-comers, and at the time of its departure had consequently become much more broad-headed. It also followed the northern route into the tropical Pacific. Most of the legends and genealogies of the Polynesians are those of the later expedition, for this became the dominant group and these superior Johnnies-come-lately had no interest in commemorating the history of those who had stolen a march on them. They were only concerned in glorifying their own exploits and pedigrees. Yet there is evidence in the people themselves that the wave of pioneers not only reached the Society Isles in central Polynesia, but extended to Samoa and Tonga in one direction and in the other to Hawaii far in the north. The second wave also drove through to the Society Islands and radiated from there.

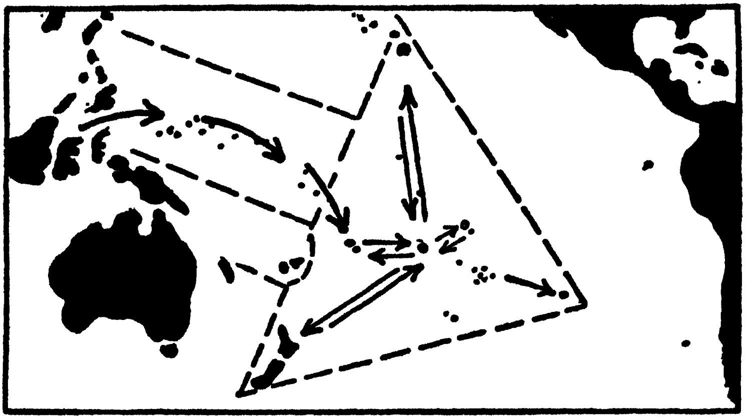
When a people migrates on a journey lasting many generations, it retains its customs and accomplishments only so far as the environment permits. No one knows what the original voyagers took with them. They may have taken many things to make their future homes more familiar, or they may have left with little besides fishing gear, stone adzes, and provisions. Taking the route they did through Micronesia, it made little difference. Before they left they may have known the loom and how to weave cloth, how to make clay pottery for cooking utensils, or how to use bows and arrows. But when they arrived on the small sandy atolls of the Carolines they could do no more than the atolls allowed, which was very little.

A coral atoll is easy enough to picture, for there is not much to see—no more than a ring of sand around a blue-green lagoon, little higher than the water within and without, and girded all around by a coral reef a few hundred yards from shore. Little grows upon it except coconut palms, vines, and a few other plants. The rain that falls sinks through the sand and joins the sea, and the only rock is soft coral sandstone storm-tossed from the outer reef. Such are the islands of Micronesia, scattered three thousand miles along the belt of Cancer. A few are volcanic, with basalt and soil, but along the eastern end there are none and the low atolls alone are there as stepping-stones. The only possible northern route leads through Yap and the Carolines, and then branches, one line to the north-east through the Marshalls to Hawaii and the other south-east through the Gilberts to Phoenix and Samoa. And steps they were, for the man at the steering paddle, no matter how stout his heart, could not go on forever, and when he reached an atoll he stopped and settled down. But an atoll is small and soon crowded, and another generation would need to go on with the search.

Life on an atoll is very different from what it is on the high islands of central Polynesia. Coconut palms grow luxuriantly and supply most of the vegetable food, together with a coarse taro grown in deep trenches and the none-too-pleasant fruit of the pandanus. Coconuts supply drink, coconut-husk fibre and leaf ribs can be made into lines, nets, and lashings. Clothing comes from coconut leaves or plaited pandanus leaves, for the paper mulberry does not grow on atolls. Firewood is scarce, but again coconut shells and dry husks come to the rescue. And as a drinking-vessel on shore and a water-tank at sea, the coconut shell saves the day. And last and doubtfully least there are the coconut crabs, bloated, purplish-blue creatures that live in holes at the base of the palms and climb the trees for nuts. They, too, enrich the diet.

So with coconut palms waving on the atolls, food and drink awaited weary voyagers from over the horizon, quite apart from the rich and varied supply of fish in the lagoon and the ocean beyond. Yet it is all too clear that any skill in weaving they might have had ceased to be shortly after the atolls were colonized, simply for lack of any materials, nor were clay pots ever made, with no clay to make them. Without the pots ordinary methods of cooking over an open fire became impossible, and atoll people evolved the Polynesian earth-oven, where the food is buried with hot stones and a low fire if necessary maintained above it.

Lagoons contain shell-fish as well as fish, and not only crayfish and oysters, but the giant *Tridacna*, the greatest clam in the world. It lives embedded in the reefs and coral sand, three feet wide and two feet deep, a deadly man-trap for anyone unwary enough to step in it. But it was the salvation of the early voyagers after they had lost touch with the volcanic islands to the west behind them. *Tridacna* shell took the place of basaltic stone, and with adzes of shell they dubbed out their canoes.



Colonial life among the atolls is obviously a clam-and-coconut affair. The clam has been there long enough, but how came the coconut? That is the question, and the answer is none too clear. Botanists, as far as I can discover, have not been able to decide whether the coconut is American or Asiatic. Its closest relatives are definitely Americans belonging to the northern part of the Andes. Does the coconut belong with its kin or has it come into being somewhere else?

Now, the coconut is a voyager in its own right, a sea-going seed evolved for oceanic travel. The question is, how much can it stand? We have in fact two alternatives—it came west across the Pacific from Central America, or east from Asia, and may or may not have had the help of man. It is difficult to decide, and both theories are attractive. The coconut undoubtedly became a coconut along a seashore, and every palm found elsewhere has had human aid. It was on the Pacific coast of Panama before the Spaniards came, and it was they who took it into the Caribbean. And it could only live along the Pacific coast between Mexico and Peru where the breeze is moist. Was this the original home and, if it was, did the nuts drift with the south-east monsoon into the north equatorial current to cross the Pacific? There is little doubt they would have done, there is more doubt that they would have lived, though it would need but a couple to root on the nearest island to start the parade.

The alternative, which seems to me to be more likely, is that it originated among the tropical coasts of the east and by some means or another has swept east across the Pacific. If it could stand the trip it might even have drifted with the equatorial counter-current clear across to Panama, though our Polynesian friends may have had a hand in this. Europeans, at least, have done their best to move it around. The Spaniards brought it to the West Indies from Panama, the Portuguese carried it down to southern Brazil and across the Atlantic to West Africa, while it had already been brought to East Africa by the Arabs.

If the coconut originated somewhere in the Western Pacific or East Indies, it is a question whether it moved far into the Pacific by drifting with the currents or in the canoes of the Polynesians. Peter Buck thinks the canoes carried it, and there is no doubt at all that some atolls have been deliberately planted by voyagers from neighbouring islands in order to make them habitable later on. Yet coconuts are built for sea voyages, and it is a curious coincidence that the equatorial counter-current commences at the Molucca Straits, where the Polynesians let go their grip on Indonesia, and flows east through the Carolines and Marshalls. These islands would have received an Asiatic coconut, even if no others did, and the Panama palms would have come from those that filtered through. Otherwise the Polynesian vanguard could hardly have survived, for atoll life evaporates without the palm and the nut; and there would not have been time to grow them after a landing was made. My own belief is that the coconut beckoned the way through the equatorial atolls, and that, knowing a good thing when they saw it, the early voyagers picked it up from there and planted the other islands ahead of occupation.

Sailing beyond the blue horizon of the South Seas required more than an urge to get out from under, whether the urge came from a real wanderlust or from discomfort at home. Only a fisher-folk could have had both the thought and the means, and canoes had to go through an evolution of their own before true migrations became possible. The first step was the conversion of a simple dug-out canoe, steadied by an outrigger and used for inshore fishing, into one that could venture far out to sea in search of bonito and deep-sea fish. This was done by adding a plank along the top of each gunwale to increase the freeboard. More planks were added when people and water supplies had to be transported, and finally, for long voyages or the transport of troops between islands, a second canoe was substituted for the outrigger. Thus were formed the double canoes used by the Polynesians in their conquest of the Pacific.

At last, when the time came for the main body of the Polynesian Expeditionary Force to follow the trail of the vanguard, the double canoes were true ships equipped with mast, sails, paddles, bailers, and stone anchors. In some cases there were three masts. Sails were rigged as sprit-sails with the apex at the foot of the mast, or as lateens, and were made of plaited pandanus mats sewed together with wooden yards and booms. Just as the Viking ships of the North Atlantic were equipped with oars, so the ocean-going canoes of the

Pacific were fitted with paddles, and with the advantage that the paddlers faced the way they were going, all watching for tell-tale clouds hanging over distant atolls and islands. The steering-paddle took the place of the rudder.

The vanguard led the way, but eventually a greater movement flowed after them, leaving a trail of coral temples through Micronesia, and in one case a virtual stone Venice of the Pacific on a now-desolate island of the eastern Carolines. This later wave was of the same stock as the first but was of a higher social grade and was led by ranking chiefs and priests with both intellect and learning. The tiny atolls to the east had no appeal, and they directed their great canoes on a south-east course that missed Samoa and brought them to the high volcanic islands of the leeward Society Isles. Here they settled, and here is the beginning of the historic Polynesia discovered by the European in the sixteenth and seventeenth centuries.

The settlement took place about the fifth century A.D.—how much earlier the first migrants trickled through to the various central and marginal islands no one knows. Even the leaders of the second group became so hazy with time that they underwent deification at the hands of their descendants. The main body established themselves in the largest island of the western Society Islands and dispersed from there to other islands, carrying with them a common basic language, religion, and cultural background of legend and tradition. They also carried along the same foodstuffs and animals.

We can imagine the joy these people must have felt when they saw the high hills and deep valleys, the streams and the soil of a large volcanic island, after generations spent on the clean but monotonous and unfertile sands of coral atolls. There was wood for canoes, bark for cordage, soil for plantations, and hard basaltic stone for tools and ovens. Everything took a new lease on life and a new civilization began, with its own art and cosmology. The old temple on Opoa still stands to some extent, the court now overgrown but the altar, one hundred and forty feet long and twenty-five wide, walled with huge slabs of coral limestone, bears witness to a past grandeur.

The Society Isles became the hub of new Polynesia, and through the centuries in which the Saxons, Danes, and Normans struggled to make England out of an abandoned Roman Britain, central Polynesia grew dense with people of high skills and social organization. Like all confined societies, internal pressures brought dissension and dissatisfaction, and striving after power. And at last the sea-salt in the blood began to course again.

The path of the setting sun drew many to the west, to find Samoa and the Tonga Islands to the south of it, sometime between A.D. 500 and 1000. Whenever it was, it was so long ago that the record has been lost in the maze of more recent events, and since every race has a need to explain to itself its own origin, the local theory is that it grew from worms. After all, while apes and monkeys show so many human features and failings that we must laugh hysterically or take them seriously, the thought of a worm as an ancestor is both solemn and broadening, and is not so silly as it sounds.

Samoa and Tonga became a cultural, trading, and fighting centre of their own, and there was an unbroken Tongan dynasty that continued from 950 to 1865. Tuitatui, the eleventh of the Tongan kings, built a monument to his two sons so impressive that imaginative writers have concluded it must have been made by some archaic preceding civilization. It is the old story, that only a very advanced civilization could have accomplished something that seems difficult to us. The monument is the famous trilithon, made of three coral limestone blocks. The uprights are seventeen feet above ground, fourteen feet wide at the base, twelve at the top, and four and a half feet thick; and the two are capped by a similar block to make an arch more than twelve feet wide, a Stonehenge at the antipodes. The shaped blocks were dragged over skids up an inclined ramp and lowered into position, as were the stone statues of Easter Island five thousand miles to the east.

Yet the importance of Tonga to the rest of Polynesia has little to do with stonework or customs. It lies in the proximity of Tonga to Fiji and the fact that Fiji was the eastern outpost of Melanesia. For Polynesia is as distinctive in its cultivation of certain plants as in its kind of people, and the journey of the plants from Indonesia is as romantic as that of the Polynesian voyagers themselves.

Very few plants suitable as food were present on the islands before the coming of men. Only purslane, seaweed, and perhaps the pandanus greeted them on the atolls, together with tree-ferns and a few berries and roots on the volcanic islands. The pandanus with its large, nourishing, unappetizing fruit and its useful leaves probably saved the day, unless the coconut was already established. Apart from these, all other plants used by the Polynesians have been human introductions, and include the bread-fruit, banana and plantain, possibly the coconut, the tuberous taro, yam, arrowroot, turmeric, and sweet potato, the paper mulberry, and the small gourd. All these, with the certain exception of the sweet potato and the doubtful exception of the coconut, originated in the Indo-Malayan region and in some way journeyed from Indonesia.

The easy solution that the Polynesian mariners brought them with them runs into difficulties because, apart from the coconut, none of them will grow on atolls. The coarse taro can be grown there but not the fine variety typical of Polynesia generally. They all require volcanic soil. Only the pandanus, coconut, and coarse taro could be relayed from atoll to atoll.

The Micronesian route therefore could not have been taken by the plants, for the volcanic islands end in the Carolines, more than three thousand miles from the Society Islands, and nearly that from Samoa, and it took a long time for the people to spread through the intervening atolls. The only route by which the plants could have been passed from volcanic island to volcanic island all the way from Indonesia to central Polynesia is the southern passage through Melanesia to New Guinea and relayed by the Melanesians there to the eastern outpost at Fiji. Canoe traffic between

Fiji, Tonga, and Samoa must have commenced very early, and there is no doubt that the plants hopped from island to island by canoe, for breadfruit and banana can be transported only as plants, and taro and yams only as tubers, and in no case could they have drifted by wind or water across the sea. The Polynesians must have visited Fiji and brought the plants back with them, for had the Fijians brought them, Samoa and Tonga would have been Melanesian colonies. Pigs, dogs, and fowl accompanied the plants, for again the coral atolls offer little chance of survival to these animals, and in actual record the atolls were without them until white men came into the picture and changed the scene. So once more the line runs along the Melanesian route to Fiji and Samoa. From Samoa both the plants and the animals were passed along to the Society Isles and Tahiti.

Tahiti was the point of departure for the later expeditions, and the animals, the plants, and the elaborate polytheistic mythology were carried along the various radials of migration, between the tenth and the fourteenth century. To the north they reached Hawaii, to the north-east the Marquesas, although the dog dropped out. The plants arrived at Mangareva from the Marquesas, but the fowl dropped out and the pig was soon lost. The Australs in the south took them all, but in New Zealand Forster and Cook found only the dog. And it is more than likely that the voyagers knew where they were going, for breadfruit and banana must be carried as tender shoots, and it is hardly likely they would have taken them on the long voyage to Hawaii, for example, if it had been a shot in the dark.

Organized expeditions were usually headed by junior members of ruling families who saw little prospect at home. Their prestige made it possible to have long-voyaging ships made, to obtain adventurous crews, and have priests on board not only skilled in navigation but well versed in traditional lore. Colonization for the most part was a process of infiltration by individual canoes, and to this day the Maoris of New Zealand do not ask a man what tribe he belongs to, but to what canoe.

Some of the most daring voyages were those of the rediscovery and development of Hawaii. I say rediscovery because the early Menehune folk were already in occupation, probably having discovered the island chain directly from the Marshalls. The later voyages took place between Tahiti and Hawaii, a stretch of two thousand four hundred miles, and probably there were also some that reached Hawaii from the Marquesas. There are a few small islands on the way that may have coaxed the travellers even one more step beyond the horizon, but at the end there are a thousand miles of only wind and water.

What led them on so far on a northern course? Only desperation or else some indication that land lay in that direction could have inspired them, and only a guess is possible. Yet we can make a guess, for the Polynesians were practical naturalists who watched the course of birds in flight as closely as did the Portuguese sailors in the Atlantic a century or two later, and it is more than likely that they followed the flight of the golden plover. This land bird migrates south from Alaska in winter to Polynesia and returns in summer. Large flocks fly to Hawaii from both the Society Islands and the Marquesas, and set a true course. It is merely substituting one mystery for another, for we are just as much at a loss as ever to account for the navigational sense of migrating birds, but at least the birds must have suggested the presence of land to the north and indicated what course should be followed. Birds, however, were not the only signs, and islands well over the horizon showed their presence by tell-tale clouds anchored like captive balloons to the land below. If a cloud had a greenish tinge it probably meant that a sunlit green lagoon lay within an atoll beneath it.

Yet the later Polynesians, if only the priests, knew more of navigation than this and steered by the stars as well as by the birds. For a while they returned from Hawaii to Tahati for more and more of the food plants, pigs, dogs, and fowl, until they at last became Hawaiians and forgot they had ever been Tahitians. The last of the traditional voyagers from the Society Isles was Paao, a priest, who arrived in about 1275.

There were two other trans-oceanic journeys, one surmised and the other history. The first is recorded by the sweet potato. It is the only food-plant in Polynesia which is unmistakably of American origin and could never have travelled alone.

The sweet potato was taken to Hawaii from either Tahiti or the Marquesas during the thirteenth century, so that it must have been in cultivation in central Polynesia some time before then. Columbus found it in Cuba and Hispaniola, and started it on its voyage round the world the other way, to Europe and Africa, while it jumped the Western Pacific from Luzon to China and Japan as late as the end of the seventeenth century. The part of the journey that lies outside of written history is the jump from America to Polynesia. Both the Mayans in Central America and the Peruvians to the south developed an advanced type of agriculture in which the sweet potato played an important part, extending into a dim past reaching back five thousand years. The immediate question is, who took the potato to Polynesia, the Americans or the Polynesians?

The *Kon-Tiki* voyage set out to prove that a Peruvian raft could drift and blow with the current and winds of the north equatorial all the way to Oceania. This raft did, although a little more to the north or a slight change in wind would have brought them to the Galapagos Islands and out of the current. If Peruvians had often gone out to sea, even by accident, it is curious that the Galapagos, only five hundred miles offshore on the equator, had not been discovered. Perhaps they had, but a raft is inevitably a one-way tripper that can never return against wind and current, as the *Kon-Tiki* men discovered too well, and unless women as well as men drifted to the Galapagos, only a bachelor boredom would have resulted. Peruvians had every reason in the world to stick as close to shore as possible and there is no evidence that they ever willingly did otherwise. All they were concerned with was a coastal salt-water highway to overcome the difficulties of travel on land, and to do a little fishing. It took the *Kon-Tiki* four months to drift across, and sweet-potato tubers go rotten in much less than that time, even if hungry men could have resisted the temptation to eat them. And no raft would have had seeds on board (the vine flowers and comes to seed in the tropics) unless a known destination lay ahead.

The alternative is that the Polynesians completed their long journey east across the Pacific, reached the American coast, stayed awhile and returned with either potato seeds or tubers. For a long time now anthropologists have accepted the idea of Polynesian contact with an extensive stretch of the American coast, and ethnographers point to a small series of Polynesian culture traits along the west coast of both North and South America. There is little doubt that they reached the coast or that they recognized the value of the sweet potato and returned with it when they could. Those who did must have returned from Peru, for the Peruvian name for the potato went with it.

Easter Island is the closest of all to the American coast, but the Peruvian potato name, *kumar*, is unknown on the coast of that latitude, and the voyages probably were farther north, within the tropics. The Marquesas on all accounts were the most likely starting place, and the deep-sea sailing canoes could have made the journey in a little over three weeks each way with favourable winds, allowing for a speed of seven miles an hour. The mariners probably expected to find land sooner, but they would have survived without much difficulty and could have sailed home again after a while, with the potato on board. In these latitudes, depending on the time of year, they could have had the wind on the beam both going and coming. Sailing canoes could have made the double journey, rafts could not, and as a little extra evidence that they did there is the probability that the South American gourd came as seeds from Polynesia, where the islanders had it under cultivation.

The potato itself, I think, deserves a little attention, for it has loomed large in the welfare of widely spread peoples. The New Zealand Maoris seem to have made the most of it, although they may have been among the last to put it under cultivation, but with them sweet-potato farming became all wrapped up in religious rites, like the corn rituals of the North American Indians. At the time of planting, whole roots are planted directly in the fields, the people all working in unison to the chant of the chief, and there are other ceremonies in connection with growing, digging, and storing. And when it is all done they hold a feast. Considering that in one of the smaller banquets more than two thousand bushels have been consumed, it surprises me that they could ever look another potato in the face!

I believe we have in the sweet potato much the same problem as is posed by the Polynesians themselves. In a way they are both artificial products, produced as a result of breeding, although more perhaps by accident than by design. The sweet potato is the original potato, the name coming from the Indian name *batata* or *padada*, and it was the potato of Europe for sixty years before the white, or Irish, potato crossed the Atlantic to compete with it and practically displace it.

The real mystery, however, is less the question of its travels than of its actual origin. We can trace the migrations of the Polynesians and the sweet potato much more accurately than we can figure out how the two races came to be what they are. In the tropics the potato is a vine that flowers and comes to seed, and it obviously belongs to the convolvulus family, in keeping with the morning-glory and bindweed, although we know it only as a tuber in the more temperate regions where we grow it ourselves. The puzzle is that of all the convolvulus tribe no single species seems to have been the parent of the sweet potato, and the potato itself does not occur in the wild—it is as much a cultivated product as a Pekinese. Yet there must have been a starting point for a potato as well as for a Polynesian, and the only wild species that in any way fits the bill is the wild Choisya of tropical America, the Caribbean Islands, and the West Indies. It is found nowhere else and is a vine with purple-pink, dark-eyed flowers, and roots that are sometimes tuberous. Cultivation and selection of the tuber-rooted plants over the years by native farmers could well have been the beginning.

But the interesting thing about it, or so it seems to me, is that the potato carries within itself some indications of its pedigree, and this shows up in the breeding from seeds rather than from vegetative rooting. Just as the Polynesians, bred among themselves, have sorted out into broad-heads and long-heads, indicating their mixed origin, so the potato yields a remarkably varied progeny and must also have had a very mixed origin. So that a variety of wild types have gone into its making and no single one is the parent stock. Whether or not the Indians who created the food-plant knew what they were doing is another matter entirely, although they must have known how good it was.

The history of man has been mainly a record of journeys of one kind or another, with the attendant results of actual displacement of people and of new and venturesome ideas, and this has been as true of the Polynesians as of any other race, perhaps more so than most.

The last of the great voyagers left the Society Isles about 1350, and sailed for New Zealand, only a few decades before the Zeno brothers ventured across the cold North Atlantic waters to Greenland and Nova Scotia. Other voyagers had made the journey before. The first were by people of the vanguard who brought no plants or animals with them and were in occupation for many centuries before the newcomers landed. They did, however, find an unexpected and easy source of food, for the moas—the giant wingless birds that used to stalk over the islands—were all too readily killed and their huge eggs too quickly eaten. By the time the later migrants arrived the moa was almost gone, and all we can find now are bones and blown eggs.

The great expedition that put the Maoris into New Zealand was a deliberate follow-up of earlier accidental visits made by canoes containing only men, one or more of which succeeded in returning with the news of discovery. A fleet of great canoes finally landed, the leaders settling on various sections of the coast in a regular settlement scheme, bringing with them the full culture, food-plants, and animals of their tropical homeland, although coconut, breadfruit, and banana failed to grow in the greater cold. Full-blooded or mixed, the Maoris remain a vigorous, intelligent, and healthy people, citizens of our own modern world, personified by Te Rangi Hiroa.

15

LONG EARS AND STONE FACES

THE TROPICAL interlude came to an end and the real journey recommenced: Was there a continent at the bottom of the world or was there nothing but a frozen sea? And, after all, what difference did it make whether there was land within or beneath the polar ice? Even now, nearly three hundred years later, it hasn't made much difference—I wonder if it ever will, although there was a time when there was no ice and the land was clothed in forest. I doubt if the reason for the voyage was more than that they simply wanted to know; there was a blank on the map as disturbing as a half-completed chord. We cannot, it seems, relax in satisfaction until the unfinished is completed—and herein lies our fate. For we do not move toward any deadly finality, "human destiny" notwithstanding, but are forever sentenced to journey into the unknown. We are, I believe, ourselves a part of a living venturesome universe and we express its quality, and the "sentence", I am convinced, is the essence of life itself.

The *Resolution* returned to New Zealand, with a reconditioned crew, for the main purpose of changing the light rigging used in the tropics for heavier gear better suited to the harsh weather and rigours of the antarctic. And so in November, 1773, James Cook worked his way once more into the world of albatrosses, skuas, penguins, seals, and seaweed drifting before the west wind. A young Tahitian, Mahine, who went along, saw snow and ice for the first time. Great icebergs once more went gliding by, the penguins, seals, and weed disappeared, and only blue petrels and the albatross remained. On Christmas Day the vessel stood across the

Antarctic Circle, food had turned bad and scurvy raised its rotten head. Misery passed through the ship, but Cook pressed on, until late in January he reached the high latitude of 71° 10′ south, only nineteen degrees from the pole, and, unknown to him, practically on the shore of the elusive southern continent. Then he himself was stricken, and to save his life the *Resolution* was turned toward the north, to head for Easter Island and some respite from trouble.

"We reached the 27th degree of S. latitude on the 8th [of March] at noon, and then shaped our course due west in search of Easter Island, discovered by Jacob Roggewein in 1722, and since visited by the Spaniards in 1770, who gave it the name of St. Charles's Island. On the 10th in the morning, the birds of the grey tern-kind were innumerable about us, whilst we advanced at the rate of seven miles an hour. We lay to during the night, being apprehensive of falling in with the land, which we actually discovered at five o'clock next morning. The joy which this fortunate event spread on every countenance is scarcely to be described."

John Davis, sailing home with Wafer on the *Batchelor's Delight* a century earlier, had sighted the island, but drove onward on the wild return journey round the Horn, without landing, reporting later that a "fair high island" lay in the Pacific in Latitude 27° south and some five hundred leagues west of the coast of South America. Men sought for it for the next fifty years without avail, and in the end it comes down to a matter of longitude. For the island lay considerably more than two thousand miles from the coast and farther than the search was thought to be reasonable. Without a chronometer the only way a pin-point island could be found anywhere was to get on to the correct parallel and run the latitude down till they came to it. The Dutchman Roggewein did just this in 1722, came to the island on Easter Sunday, gave it the name of Easter Island, slaughtered some natives, and brought back tales of tall stone idols with red hats on their heads. Cook found the island by the same method, although since its approximate longitude was now known, he had only to be sure whether he was east or west of the island when he reached the 27th parallel. The chronometers on board the *Resolution* were not so much for navigating, for in any case longitudes were not correctly known except in a few instances, as for surveying, determining accurately the longitude of each cape, bay, and island encountered, checking whenever possible with the more reliable method of celestial observations. Of the two chronometer watches, which had each taken a year to make, one "was unfortunately stopped immediately after our departure from New Zealand in June 1773, but the other went till our return to England, and gave general satisfaction. It appears however that in the long run the observations of distances of the moon from the sun or stars, are more to be depended upon, if they be made with good instruments, than the watches or time keepers, which frequently change their rates of going."

Two days later they dropped anchor in what has ever since been called Cook Bay. A solitary outrigger canoe—"patched up of many pieces, each of which was not more than four or five inches wide, and two or three feet long"—came out to meet them, with two natives aboard, each naked body tattooed all over, with ears so pierced and stretched that they hung down to the shoulders. They called for a rope, using the Tahitian word for it, and "we had no sooner thrown them the rope, than they tied a great cluster of ripe bananas to it, making signs for us to haul it up. The sudden emotions of joy in every countenance, at the sight of this fruit, are scarcely to be described". The construction of the canoe indicated a scarcity of wood and "we could easily perceive that there was not a tree upon the whole island, which exceeded the height of ten feet".

On shore they found a people like the Tahitians except for a slightly Negroid cast of countenance, living in miserably poor stone huts, virtually without cloth or clothing, and struggling to cultivate small plantations of sweet potatoes, bananas, sugar-cane, and mulberry trees. The whole island appeared to be covered with large rubble of a reddish rock, and was without water except for scattered puddles. And the wind swept across it from one end to another, from this quarter and that, while a hot sun baked whatever walked abroad.

The Forsters went exploring and collecting as their nature dictated and, like those before and all who came after, were struck with wonder at the statues of Easter. Even at this distance and through the eyes and pictures of others I find them haunting, like a bell ringing through the years long after it was still.

"After staying among the natives for some time on the beach, we began to walk into the country. The whole ground was covered with rocks and stones of all sizes, which seemed to have been exposed to a great fire, where they had acquired a black colour and porous appearance. Two or three shrivelled species of grasses grew up among these stones, and in a slight degree softened the desolate appearance of the country. About fifteen yards from the landing-place we saw a perpendicular wall of square hewn stones, about a foot and a half or two feet long, and one foot broad. Its greatest height was about seven or eight feet, but it gradually sloped on both sides, and its length might be about twenty yards.

"A remarkable circumstance was the junction of these stones, which were laid after the most excellent rules of art, fitting in such manner as to make a durable piece of architecture. The stone itself of which they are cut is not of great hardness, being a blackish brown cavernous and brittle stony lava. The ground rose from the water's side upwards so that another wall, parallel to the first, about twelve yards from it and facing the country, was not above two or three feet high. The whole area between the two walls was filled up with soil and covered with grass. About fifty yards to the south there was another elevated area, of which the surface was paved with square stones exactly similar to those which formed the walls. In the midst of this area, there was a pillar consisting of a single stone, which represented a human figure to the waist, about twenty feet high, and upwards of five feet wide. The workmanship of this figure was rude, and spoke of the arts in their infancy. The eyes, nose, and mouth were scarcely marked on a lumpish, ill-shaped head; and the ears, which were excessively long, quite in the fashion of the country, were better executed than any part, though a European artist would have been ashamed of them. The neck was clumsy and short, and the shoulders and arms very slightly represented. On top of the head a huge round cylinder of stone was placed upright, being above five feet in diameter and in height. This cap, which resembled the head dress of some Egyptian divinity, consisted of a different stone from the rest of the pillar, being of a more reddish colour; and had a hole on each side, as if it had been made round by turning. The cap, together with the head, made one half of the whole pillar which appeared above ground. We did not observe that the natives paid any worship to these pillars, yet they seemed to uphold them in some kind of veneration, as they sometimes expressed a dislike when we walked over the paved area or pedestals, or examined the stones of which it consisted. . . . The great correspondence in the features, customs, and languages of these people, to those of other natives of the South Sea islands, gave us some hope for such domestic animals among them, as we had observed at Taheitee or New Zealand. But notwithstanding the most diligent search, we never met with any other than the common fowls, which were of a small breed, and had a dull plumage. . . . We found the whole country strewed with stones of various sizes, of a cavernous or spongy texture, and of a black, brown, or reddish colour, which had indubitable marks of having been in a volcanic fire. The paths through this rugged ground are in some measure cleared of the stones, but so very narrow that we were obliged to turn our toes inwards, at which the natives are perfectly expert, and to set one foot exactly before the other. This mode of walking was excessively fatiguing to us who were not used to it, so that we continually hurt our feet or stumbled. . . . We reached the east side of the island, near a range of seven pillars or statues, of which only four remained standing, and one of them had lost its cap. They stood on a common pedestal, like those which we had seen on the other side, and its stones were square and fitted exactly in the same manner. Though the stone of which the statue itself is formed seemed to be soft enough, being nothing but the red *tufa* which covers the whole of the island, yet it was incomprehensible to me how such great masses could be formed by a set of people among whom we saw no tools; or raised and erected by them without machinery.

"The most diligent enquiries on our part, have not been sufficient to throw a clear light on the surprising objects which struck our eyes in this island. We may however, attempt to account for those gigantic monuments, of which great numbers exist in every part; for as they are so disproportionate to the present strength of the nation, it is most reasonable to look upon them as the remains of better times. . . . The remains of plantations on the summits of the hills give strength and support to this conjecture. It is not in our power to determine by what various accidents a nation so flourishing, could be reduced in numbers, and degraded to its present indigence. But we are well convinced that many causes may produce this effect, and that the devastation which a volcano might make, is alone sufficient to heap a load of miseries on a people confined to so small a space. In fact, this island, which may perhaps in its remote ages, have been produced by a volcano, since all its minerals are merely volcanic, has at least in all likelihood been destroyed by its fire. All kind of trees and plants, and domestic animals, nay a great part of the nation itself may have perished in the dreadful convulsion of nature: hunger and misery must have been but too powerful enemies to those who escaped the fire." As guesses go, this seems to me to be as good as most and better than some!

Some things Forster failed to see—carved cadaverous figures of wood, with protruding ribs and vertebrae, with hollow eyes, and long ears stretching down toward the shoulders, in their own way as striking as the stony statues, though they tell a clearer story.

There were other pieces of wood, also of a size to be easily hidden, covered with row upon row of picture-writing that some have seen to resemble India's ancient hieroglyphs. And no one climbed the crater rim of Rana Raraku to discover the abandoned workshop of the statue-makers. Had Forster done so, I am sure he would have stood in as wild a surmise as Cortez is said to have done on a peak in Darien!

The mysteries of Rana Nui, the old name now given on modern maps to Roggewein's Easter Island, have only seemed to deepen as the years have gone their way. Apart from a thin trickle of pedigree, all living connections with its ancient people has gone, for sailors, slavers, disease, and destruction have left no more than a battered remnant on a barren island. Memory lingers on, but verbal history at its best makes an unreliable record.

Easter Island lies farther to the south than Capricorn, two thousand miles west of the Andes, and a thousand or more beyond the edge of the Peruvian current swinging west along the equator. No island lies more isolated or has been harder to find, and only fitful winds from the Tuamotus and Marquesas, a thousand miles west by north, tie its volcanic bleakness to any other lands. Throughout the year, from this way and that, the trade winds blow across the lava plain lying between the cratered corners, for Easter lies at their heart. No coral reefs guard the island, no coconut palms line the shores, no sandy beaches serve canoes, only cliffs of lava and basalt stand high and jagged from the ocean, the raw and broken top of a none-too-old volcano rising twelve thousand feet from the bottom of the sea.

According to the legend, King Hotu-matua of the land of Marae-renga set off on a voyage to the east in a great double canoe, ninety feet long and six feet deep. His master craftsman, Tukoihu, accompanied him in another canoe, and together they landed with two or three hundred men and women, to find a land destitute of trees and all green things except grass and creeping vines. They brought with them the seeds of the paper mulberry tree to grow fibre for cloth, hibiscus and mimosa to give glue and wood for canoes and ceremonial staves; peach, plum, cherry, and orange to give forth fruit; coconut for drink and plants, roots or seeds of tomatoes, gourds, sweet potato, yam, taro, and tobacco for sustenance and solace. At first, or so the legend says, everything grew abundantly in the dark lava soil—what there was of it—but gradually the island asserted itself and the incessant salt-laden winds and impoverishing soil brought the trees down and made living even more arduous. The Polynesian language of the islanders indicates that at one time they knew the pig and the dog, but tradition tells that they were eaten before they could propagate. You can hear the argument ringing yet: "If we don't eat them now we will starve!"—"If you do eat them now you will starve!" It was a choice of two evils, and evil won.

So much has been written about Easter Island with its long-eared natives and arrogant stone faces, so many have wondered and speculated, those who have seen it and those who have not, that a guide must be chosen with care. I follow a team, Peter Buck and Alfred Metraux of the Franco-Belgian Expedition, the last to study the island, who combined their vast experience to disentangle the tale.

If it were not for the stone statues I doubt whether the people of Easter would have called for much more attention than those of any other small island on the margin of Oceania. It is large-scale sculpture and a feat of transportation which superior white men cannot reconcile with the capacities of a primitive Stone Age people. The Nordic myth is a stubborn weed, and we see it in a recent theory that the architects of the great structures of Yucatán and Peru were bearded white men who drifted across the Atlantic long before Columbus, to confer badly needed brains upon a less ingenious people, white men who later were driven south by the Incas, forced to escape by raft into the open Pacific, and, drifting to Easter Island, built stone platforms and carved and transported the statues by virtue of their past experience. It seemed inconceivable in a land so destitute of timber that wood was the most valued of all materials, that men with no more than stone chisels could have accomplished what obviously has been done, although the problem is hardly simplified by changing the colour of their skin. It merely adds an unnecessary and unwanted mystery of an evanescent white race that came from nowhere and lives no more.

Altogether the theories put forward to account for the transportation of the statues from the workshops on the volcano to other parts of the island are a striking tribute to the romantic imagination of mankind. One of them, which has had much appeal, is that of a sunken archipelago or continent, the story of the lost Atlantis put into a Pacific setting. It is a logical theory based on the doubtful premise that only enormous armies of slaves, numbering tens of thousands, could have accomplished the engineering feats of Easter. Since the little barren island on which the statues stand could never have supported such a population, let alone the community from which it was drawn, it follows that the workers must have come from far more extensive lands. No such land at present exists within a reasonable distance, therefore it must have sunk beneath the sea, carrying everything and everyone with it except the peak of Rapa Nui—a catastrophe so sudden that the workmen carving on the crater threw down their tools and fled, never to pick them up again. There is glamour in the idea of an advanced and cultured civilization sinking beneath the waves: the story of the Flood in another form. The flaw is that no geologist will admit that Easter has ever been more than the top of an isolated submarine mountain. It rises from an abyssal oceanic plain twelve thousand feet below the surface, and no submerged ridges or islands exist in the south-east Pacific to suggest there was ever more land above the sea than there is at present.

One of the latest theories rests upon a legendary account of flying red birds and upon the islanders' explanation of how the statues came to be placed. They say no man put them where they are and that they were sent through the air. The theory suggests that they were sent from the volcano to their particular destinations by a volcanic eruption, an activity which, after all, may all too readily toss boulders some distance from the crater. But the idea is not left there, and it is supposed that the carvings were at least partly completed within the crater, the statue faces were covered for protection, and at some undetermined time the volcano belched and the trick was done. It seems to me about as plausible as another modern romance, that Venus swung around the earth and stopped its rotation for a day, without shaking loose every man, monument, and mountain on the planet; and in this connection I would have thought that Wells's *The Man Who Could Work Miracles* had properly disposed of the myth of Joshua's stopping the sun, forever.

A mysterious white stranger, a sunken archipelago, and spooky volcanic levitation have something in common. They seem to belong more to the medieval dream-world than to our own time, and all transgress a basic rule of procedure in scientific inquiry, which is to search for the simplest explanation without making unnecessary assumptions.

The transportation of the heavy stone statues is admittedly not easily understood, but there is no need to assume actions and intentions that may never have existed. The problem is not uniform. The statues placed around the slopes of Ranoranaku stand fifteen to twenty feet and are essentially busts above the ground, with a peg-like base anchoring them deeply and firmly.

Those which stood on the platforms on the cliffs some miles from the crater were somewhat smaller and had flat bases to stand on the stone masonry. They stood ten to fifteen feet high and weighed about four or five tons. The stone itself was soft vocanic rock so porous that rain falling on the island sank through to sea level to emerge as springs along the shore, relatively light and easily carved.

Other statues stand or lie within the crater itself, and some investigators have assumed that the crater was the workshop, and that all statues were either carried up and over the crater rim or were destined to be. Many stand erect near the edge of the crater lake. The greatest statue of all lies recumbent and only partly detached, nearly sixty feet long, below the cliffs, within the crater. It is this one above all that led to the need for a sunken land to produce the men that would be needed to raise it above the rim and carry it to a distant destination.

The workshop actually was both within and without the volcano. The brooding giants at the base of the slopes were cut from the upper ledges and slid down. The empty niches and some partly cut figures near the top clearly show their origin. So were the statues within the crater carved below the rim and then moved down toward the lake. And there is neither evidence nor good reason to suppose that the great prostrate giant was intended ever to be moved or even to stand erect. Hawaiians, Tahitians, and Marquesans moved large masses of stone and set them in place with ropes, wooden props, levers and skids, and built up inclined planes to accomplish their tasks. Peter Buck doubts that the images were heavier than the logs the Maoris dragged from the forest for their war canoes, and believes a team of fifty men could have handled any image that had been moved, and considers the resurrection of an extinct civilization from a sunken continent to do what the Easter Islanders accomplished unaided is the greatest compliment ever paid to an efficient Stone Age people.

Like other Polynesians, the Easter Islanders kept the royal genealogy, and Metraux reckons that Hotu-matua landed on the island about A.D. 1150. Intertribal wars were frequent, and the legend of a war between long-ears and short-ears suggests that there were two early groups of settlers, one with ears pierced and stretched to carry heavy ornaments coming from the Marquesas, where this was a habit, and the other with ears unpierced coming from Mangareva. The long-ears are supposed to have made the stone images and temple structures, and lived on the eastern part of the island; the short-ears had the more fertile land in the west. When the short-ears refused to carry stones to assist the long-ears in building a temple, war was declared and the long-ears were the ones to be nearly wiped out. This may well account for the sudden stoppage of work in the image quarry and the beginning of knocking down of the statues from their platforms.

Marquesans carved large stone images and built retaining walls of stone, the Mangarevans did not, and it is more than likely that the Mangarevans were there first, took the best land for their plantations, and had no concern in portraying their religion in stone—they may have been part of the first migratory wave of Polynesians through Oceania.

The long-ears, coming from the Marquesas, with indications of a Melanesian influence in the length of their ears, may have been a later wave, carrying with them their ritual of stone-working, occupying the second-best locations up the mountain-sides, and attempting as a superior caste to impose their rocky religion on the whole population. I can find no reason to suppose that an aggressive missionary spirit in the South Seas has been limited to Christians; we all have it more or less, I think. Large stone images were made by the Polynesians in the Society Islands and the Marquesas on the main migration route, and farther afield in Hawaii and New Zealand. Coming from the Marquesas, it is not surprising that Easter Islanders carried the memory of stone carving to their new home, where they evolved a local pattern suited to the soft and easily worked volcanic stone found in and around the crater of Rano-raraku.

The images are really busts, with long bodies and high faces. Forster's description of them as crude pieces of work demonstrated a lack of appreciation of a form that departed too far from the accepted pattern. For the sculpture is highly stylized and shows a face with proud pursed lips and an imperious mien. Two assumptions have frequently been made about the heads which I think are questionable. One is that the pointed chin represents a beard, and the other that the ears are stretched as for ornaments. Short beards were not unknown among both Easter Islanders and Marquesans, and long ears have also certainly been in fashion at some time. But the more you look at these stony, confident, intelligent faces, the more they become a normal clean-cut but stylized type. The ears are long, but so is the whole head, and the ear-lobes are as high above the angle of the jaw as mine or yours. The suggestion that they represent images of their human creators carries no more and no less weight than a similar statement made about any other Polynesian image; and if some of them should come to life, like the Marquesan image with round owlish eyes, winged nose, and mouth stretching from ear to ear, the effect would be sheer nightmare.

The small carved wooden images with protruding ribs and sunken abdomens represent the spirits of the dead and resemble others found through much of Polynesia and points west. The stone images may have represented gods or deified ancestors originally, but eventually they became more an expression of art. Flat-based images went to the temple platforms, but the larger peg-based statues were used chiefly to ornament the landscape and mark boundaries and highways. All images left in the quarry were pegged, so that all platform orders had been filled and highway decoration was under way when civil war or contact with white foreigners brought everything to an end.

The wooden tablets with alternating rows of incised symbols have been the greatest of the Easter mysteries. Hotu-matua was said to have brought sixty-seven of them with him from legendary Marae-reuga, in which case they must have been in use in that land. Nothing of the kind is known or remembered in either the Marquesas or Mangareva, so they must have come from a more distant region or else have been evolved on Easter Island itself. Tracing the characters on the tablets back to the Indus Valley picture-writing implies a continuity without significant change extending over thirteen thousand miles and three thousand years, with no trace between. When you think how easy it is to forget a telephone number, the idea becomes fantastic. Besides, the alternate right and left, right-side-up and upside-down arrangement of the Easter tablets is lacking in the Indus script. Every piece of an Easter tablet is completely covered, and some pieces were made from oar-blades of

European ash that drifted ashore around the time of the *Resolution's* visit. Buck and Metraux are agreed that the tablets are not particularly old, that the characters are purely pictorial and are not a form of writing, and were originally carved on ceremonial staves of hibiscus. As wood ran short, any piece became valuable and took the place of the stave, to be held in the hands while chanting religious ritual. Like the enlargement of images because stone was soft, and like the piecing together of a canoe from small pieces of wood because there was no other kind, the decorated tablets become just one more instance of a Stone Age folk adjusting themselves to life on an island which they had better never have discovered.

Rapa-nui has been an island of death and disaster, and the men of the *Resolution*, like all who have been there since, sailed away with a sense of relief that their visit was over, and Cook took his ship back through the tropical islands once more to New Zealand.

16

THE SEA OF WHALES

Tropical islands and polar ice took their toll, and the time came to go home. A course was steered south and east from Cook's Strait between the north and south islands of New Zealand, heading for Tierra del Fuego. No land stood in the way, no volcanic islands, not even ice, and only the west wind blew on its roaring way forever around the world. The *Resolution* spread her wings, I was going to say, and soared like an albatross—but it would be nearer to the truth to picture a hen trying to get off the ground, for Cook's ships were not the best of sailers. Forster himself says that the *Resolution* was a dull sailer, but with the wind driving her steadily to the east she did manage a fair hundred and twenty miles a day, an average of four and a half knots, which is at least twice the speed at which Columbus drifted across the Atlantic. So they plunged gaily ahead before the following wind, rolling thirty degrees each way and occasionally forty. Probably by this time nothing mattered, not even the everlasting salted food from the ship's stores, as long as the end of the voyage was in sight. Yet the wind blew without intermission, and with only the sea and the sky, petrels and penguins, sooty and wandering albatrosses in sight, they crossed the far South Pacific, reaching Cape Horn, five thousand miles away, in forty days.

Only the start and the finish of the passage were marked by novelty. With New Zealand barely out of sight Forster saw what he describes as a whale twelve yards long, with an oblong, blunt head that had two longitudinal furrows and two ridges, with small eyes and a pair of semi-lunar openings which occasionally spouted water, a body mottled all over with white spots, and a pair of large fins behind the head but not on the top. The description is clear enough, and it was the same kind of sea monster that almost scared the living wits out of the happy voyagers on the *Kon-Tiki* raft, no whale at all, but the whale shark. Like the largest of the whales, the largest of the sharks is dangerous only in its powerful, blundering bulk. Neither is equipped to carry the war to the enemy, and their own safety lies in their size. Both attain giant dimensions by cutting out the middle-men of food, and have given up chasing fish or squid a little smaller than themselves, going almost down to the grass roots to feed on the inexhaustible supply of small crustaceans. And both the biggest whales and whale shark plough the ocean with mouths open to strain the sea of the finer things of life.

At the eastern end of the traverse the low black islands of western Tierra del Fuego loomed one December night. Snow on higher lands behind them came almost down to the water, and the rocks and water were thick with shags, skuas, and shearwaters, and other shallow-water fishermen. The cold haze cleared in the morning as they sailed just beyond immense beds of floating kelp which lined the island shores. Killer whales played in couples, and ducks as large as geese, that the sailors called racehorses, amazed them all by running along the sea with startling speed, beating the water with feet and short wings.

Rounding the Horn they came into waters teeming with seals and sea-lions, with rocks and islands dense with shags and a new kind of penguin, and last and probably least, Tierra del Fuegans themselves. I say least because every person who ever saw them described these people, pushed as they were into the desolate sanctuary beyond the Strait of Magellan, as the most miserable and disgusting human beings they had ever seen. Forster describes them as about five and a half feet high, with broad faces, flat noses, high cheekbones, straight hair, bony, under-nourished bodies, and forever-running noses.

The bleak archipelago was soon and willingly left behind and the *Resolution* sailed across the Scotian Sea, the deep ocean pocket enclosed in a bulging net of islands swinging in a great arc east, south, and finally west, from South America to the antarctic, a true extension of the Pacific Andes into the Atlantic. It is the home of whales, and man now enters it only as a murdering menace to all its sea mammals. Forster saw "a number of large whales, not less than thirty, and some hundred seals, playing in the water about us. The whales went chiefly in couples, from whence we supposed this to be the season when the sexes meet. Whenever they spouted up the water, or, as the sailors term it, were seen blowing to windward, the whole ship was infected with a most detestable, rank, and poisonous stench, which went off in the space of two or three minutes. Sometimes these huge animals lay on their back, and with their long pectoral fins beat the surface of the sea, which always caused a great noise, equal to the explosion of a cannon gun. This kind of play has doubtless given rise to the mariner's story of a fight between the thresher and the whale, of which the former is said to leap out of the water, in order to fall heavily on the latter. We discerned that all the belly and underside of the fins and tail are of a white colour, whereas the rest is black. As we happened to be only sixty yards from one of these animals, we perceived a number of longitudinal furrows, or wrinkles, on its belly, from whence we concluded it was the species by Linnaeus named Balaena boops."

It is a sea of whales, giant blue and fin whales straining the water for its krill, with the great whalebone sieves hanging in their mouths, toothed killer whales hunting in packs like wolves, tearing at their greater relatives and gulping whole any porpoise, seal, or penguin unfortunate enough to be too close. Yet shrimp eater or whale destroyer, whales are a group apart, whether blue and fin, sperm and humpback, killer or porpoise, all of them breathe air with lungs and have warm blood, all bring forth living young and suckle them with milk, and most of them have a few scattered hairs on the snout and chin as a reminder that once upon a time, some sixty million years or more ago, they wore a hairy coat and walked upon the land. Since that far and forgotten time whales, large and small, have evolved a streamlined body as good as any fish, have made flippers out of forelegs, and got rid of hind legs altogether except for rudiments embedded in the tissues, and changed a pointed tail into wide horizontal flukes to form the driving propeller.

They are amazing mammals, the largest far exceeding the size of any other animal that has ever lived. Until recently we assumed that the largest whales grew slowly and to a considerable age before they matured, but the facts are otherwise. The largest of all whales, the blue whale, can reach a length of a hundred feet, but out of thousands examined only one was as old as thirty years and most were well under ten. For the blue whale is twenty-five feet long at birth, and at two years is seventy feet long and ready to breed. It carries its young for twelve months, suckles it for six, and takes half a year off to be itself alone. And blue, fin, and humpback follow the krill from the antarctic ice to warmer waters and back, breeding in the Temperate Zone in the southern midwinter and only venturing south with their young as the summer approaches. Forster may have seen a community of young breeders on their first trip north.

The Scotian Sea was quickly crossed and the ship came within sight of a high peaked glacial island which Cook named South Georgia—"here Captain Cook displayed the British flag and performed the ceremony of taking possession of these barren rocks . . . in the name of his Britannic Majesty, and his heirs for ever". A volley of two or three muskets was fired into the air to give greater weight to this assertion; "—and the barren rocks re-echoed with the sound, to the utter amazement of the seals and penguins, the inhabitants of these newly discovered dominions". They found there more than these, and not only the expected terns, shags and albatrosses, but the majestic king penguins forty inches high, with their yellow-and-black beauty spot, and above all the sea-elephant with its trumpet nose, a monument of ugliness. Nowadays it is the head-quarters of the land-based whaling industry and of the *Discovery* Expedition, a semi-permanent investigation into the habits and welfare of the great whales, an expedition named for the first ship it employed—the *Discovery* employed by Scott for his 1901 antarctic expedition, and so named by him after the first *Discovery*, the ship Cook commanded on his third and last voyage into the South Seas. Now there is a third *Discovery*, a steel ship with steam and sail, a floating biological laboratory that ranges the sub-antarctic. Ships live on, as well as men.

Impatience to get home increased and at last the high Georgian peaks towering in the clouds faded away over the horizon, and the *Resolution* took an uneventful course across the South Atlantic to Cape Town, where the ships and the news of the world awaited. "Besides the great annual fleet of Dutch Indiamen, we found—French vessels from the Isle of France, several Danish and two Swedish Indiamen, a Portuguese ship of war, and three Spanish frigates, one homebound from Manila. The great events which had happened in Europe during our absence crowded in upon us unexpectedly. Sweden delivered from the yoke of aristocratical tyranny, by a young hero; the barbaric darkness, which in the east of Europe and Asia had baffled the Herculean power of Peter, dispelled by a princess; Poland restored to peace, from anarchy and the horrors of civil war; and Frederick the Great resting from his triumphs, and sacrificing to the Muses in the shade of his laurels." And to cap it all, on the last lap home, even the Spaniard was friendly: "Our ship's company being well refreshed and in perfect health we prepared to sail with the first fair wind. . . . The Spanish frigate, *Juno*, saluted us with nine guns; which unexpected mark of politeness our gunners returned a full quarter of an hour afterwards."

With thoughts of peace and a golden age for Europe the company returned, Cook to sail in the *Discovery* a year later, to his death in the Pacific, Forster to find a world in revolution, American and then French, and to find his own fatal frustration as a new France came into being. With the closing years of the century the torch passes into other hands.

Franklin did not see it finish either, but his younger friend Thomas Jefferson, as the century turned, rode horseback to his inauguration as president with his saddle-bags filled with specimens of fossil bones on which to lecture before the American Philosophical Society. The New World was beginning to look at itself from within.

III

THE POLES AND THE PLANET

17

LIVING LIGHTNING

THE SIXTEENTH and seventeenth centuries saw men journey across the face of the globe. Their minds went to the stars in their courses, a journey that may never end. The eighteenth century saw something different. The celestial wonder grew, but lost a little of its novelty; the earth was spinning on its axis, circling the sun, and the sun itself becoming a star—and with all the system set in motion, the mind turned to closer things. Thunder and lightning came down to earth, like Newton's apple, to become almost a plaything in the hands of men. Heat became energy, no longer a substance, and the air itself gradually became the mixture of gases we now know it to be. Yet understanding or discovery is the personal experience of individuals, and I think should not be divorced completely from them. The analysis of air was made not by professional scientists—there were no such creatures—but by two men of very different status: Joseph Priestley, a liberal-minded, large-hearted nonconformist English clergyman, who fled to the young United States from the wrath of a mob incensed at his liberal theology and his sympathies with the French Revolution; and Lavoisier, who gave the name of oxygen to Priestley's "dephlogisticated air", and lost his head beneath the guillotine for having operated a royal tax-collecting business.

The sense of wonder remains, in spite of strife and turmoil, but it turns from the marvellous to the commonplace. Chemists have taken the place of alchemists, just as astronomers displaced astrologers before them. The revolutions caused some men to flee and some men to die, but revolutions do more than that—they loosen or cut the cords to the past, for the destructive or sceptical attitude extends to the authority of thought as well as the authority of person. And in France especially the questions arose to challenge the old-established dogmas. I do not think that challenges of this kind are always consciously made; it is more a case of the dogma itself losing strength; the mind is freed to look where it could not look before, and may be startled at what it sees. And so we come to an age already thinking in terms of chemicals and energy and turning to look at what is near at hand, though not necessarily close to home. Men begin to study seriously the plant and animal life around them, or wherever they can find it, with much more than the casual interest of the past.

When the last year of the eighteenth century slipped away another young man sailed aboard a wooden ship and watched the Spanish coast fade out of sight. As the nineteenth century was born, Alexander von Humboldt crossed the Atlantic and stepped through the curtain Spain had drawn around her conquests for three hundred years, armed with passports from Madrid. He was older by more than ten years than Forster and Dampier when they had first set sail, ten years packed with preparation of mind and equipment for an expedition breath-taking in its mental reach. Georg Forster died in the first year of the French Republic, but not before his spark had inflamed the younger man, not through the accident of a book but from the full and direct association of mentor and disciple. From the fall of the Bastille until the fall of the royal heads, Forster was librarian to the elector of Mainz, and during this time he went on geological and botanical expeditions along the Rhine to Holland and England, with Humboldt as an enthralled companion. For the next eight years Humboldt travelled from one European country to another, hampered by warfare but constantly studying rocks, volcanoes, plants, and animals, as one scheme after another for exploring the tropics broke down. With Forster's dreams in his mind, and in Paris encouragement from Captain de Bougainville, Humboldt and his botanist companion, Bonpland, at last found their way to Madrid, and unexpectedly received passports from the Secretary of State and the Council of the Indies—"never had so extensive a permission been granted to any traveller, and never had any foreigner been honoured with more confidence on the part of the Spanish Government". So it was, in June, 1799, the two men sailed from Corunna for the Spanish Main on board the *Pizarro*, a Spanish ship named in honour of the man who destroyed the Incas. It was their regret, as it is mine, that Forster had not lived to accompany them.

It is a change to sail once more from a Spanish port, the more so with Nelson in command of a blockading English fleet fresh from victory over Napoleon at the Battle of the Nile. The second day out "at sunset, we descried from the mast-head an English convoy sailing along the coast, and steering towards the south-east. In order to avoid it we altered our course during the night. From this moment no light was permitted in the great cabin, to prevent our being seen at a distance. This precaution, which was at the time prescribed in the regulations of the packet-ships of the Spanish navy, was extremely irksome to us during the voyages we made in the course of the five following years. We were constantly obliged to make use of dark-lanterns to examine the temperature of the water, or to read the divisions on the limb of the astronomical instruments. In the torrid zone, where twilight lasts but a few minutes, our operations ceased almost at six in the evening. This state of things was so much the more vexatious to me as from the nature of my constitution I never was subject to sea-sickness, and feel an extreme ardour for studying during the whole time I am at sea."

The ardour is felt at once. Everything that came within reach of his senses came under the scrutiny of Humboldt's vigorous mind, the first being the equinoctial current flowing to the west—"the movement of the ocean in a direction contrary to that of the rotation of the globe is probably connected with this last phenomenon only as far as the rotation converts into trade winds—the limits were, for the first time, determined by Dampier—the polar winds, which in the low regions of the atmosphere bring back the cold air of the high latitudes towards the equator". And the long discussion that follows expresses the new world of thought, where electricity, gases of hydrogen, oxygen and nitrogen, barometric pressure, and salts and molecules, take the place of lightning, air, and water. For in spite of war and revolution, Western thought was quickening, and physical and chemical science had found its feet. No one was more alerted to it than our Alexander, and no one ever made greater use of his information or carried more up-to-date equipment. He had thermometers and barometers, batteries and galvanometers, apparatus for gas analysis, astronomical instruments, and anatomist's dissecting tools. It sounds more like a modern research laboratory, but it was the field equipment of one man intent on exploring a tropical rain-forest and the peaks of the Andes; and for the most part the apparatus and knowledge were inventions and discoveries of the previous decade. I do not believe that the first space-ship destined for Mars in the coming millennium could represent more enterprise, courage, and preparedness than Humboldt bore as an individual a century and a half ago. He took into the richest parts of an almost unsullied earth all that was known of the universe in his time, and surveyed and analysed all that came his way.

The passage to Teneriffe was uneventful except to a naturalist. Humboldt and Bonpland looked in vain for ocean weed, but were startled at the abundance and variety of jelly-fish—some blue, some yellow-brown, some purple: swarms that took an hour to pass the ship. The jelly-fish were as of old but the men were new, and this time "if we place a very irritable medusa on a pewter plate, and strike against the plate with any sort of metal, the slight vibrations of the plate are sufficient to make this animal emit light". Speaking of phosphorescence of wood, "I have proved by experiments published in 1797, that the shining of wood is extinguished in hydrogen gas, and in pure nitrogen gas, and that its light reappears whenever we mix with it the smallest bubble of oxygen gas. These facts tend to explain the causes of the phosphorescence of the sea, and of that peculiar influence which the shock of the waves exercises on the production of light."

North of the Cape Verde Islands they passed through great masses of floating weeds and as usual speculated about them. Floating weeds must have been torn from submarine rocks, "possibly by fish and molluscs", and there is no suspicion that the weed vegetatively propagates free of any attachment and is as ancient an inhabitant of the open ocean as the flying fish itself. Yet it took more than another century for this to be recognized, and Humboldt's point of view and natural philosophy are shown well in his account of flying fish. The fish is the same but the man is different, and his own words are better than mine, "from the twenty second degree of latitude, we found the surface of the sea covered with flying fish, which threw themselves up into the air, twelve, fifteen, or eighteen feet, and fell down on the deck. I do not hesitate to speak on a subject of which voyagers discourse as frequently as of dolphins, sharks, sea-sickness, and the phosphorescence of the ocean. None of these topics can fail to afford interesting observations to naturalists, provided they make them their particular study. *Nature is an inexhaustible source of investigation, and in proportion as the domain of Science is extended, she presents herself to those who know how to interrogate her, under forms which they never yet examined.*"

Here is the essence of scientific progress, even human progress if you like, a continuing re-examination and redescription of life and the universe in terms of progressively deeper insight. In practical detail he continues: "I have named the flying fish, in order to direct the attention of naturalists to the enormous size of their swim bladder, which, in an animal of 6.4 inches, is 3.6 inches long, 0.9 of an inch broad, and contains three cubic inches and a half of air. As this bladder occupies more than half the size of the fish, it is probable that it contributes to its lightness. We may assert that this reservoir of air is more fitted for flying than for swimming . . . some naturalists think that within the tropics, in sea fish, the organ must be filled with pure oxygen. Full of this idea, I was surprised at finding in the air-bladder of the flying fish only 0.04 of oxygen to 0.94 of nitrogen and 0.02 of carbonic acid." The flying fish remains the prey of frigate and bonito, but it becomes also a question of flight mechanics and the physiology of power, and it is surprising to find analyses such as this, and others, being made so soon after the very existence of oxygen itself had been recognized.

Yet I think we need to recognize the crucial quality of the ten years preceding Humboldt's departure. Forster, and through him the younger man, must have been acutely aware not only of the new knowledge in chemistry and physics, but also of the emerging figures of two French biologists, Jean Baptiste Lamarck and the Baron Cuvier. And after Forster's premature death, Humboldt would have schooled himself in what Cuvier in particular was doing. Lamarck he may not have taken seriously, for this gentleman was only the poverty-stricken custodian of the herbarium of the guillotined King Louis, and his thoughts on how the giraffe came by its long neck, the snail by its shell, and man by his intelligence, may have been too tentative at the time. The baron was another matter, for Cuvier was a young man of the same age as Humboldt himself, brilliant and vigorous even during the last eighteenth-century decade when Humboldt was intermittently haunting Paris. And Cuvier's main interest and great repute concerned the objective study of the anatomy of animals and of their fossil remains. What Humboldt did was to acquire this interest himself and combine it with his passion for physics and chemistry, and become the first man, I believe, ever to look upon and study an animal as a whole—its shape, its structure, the working of its parts, and the chemistry of its substance—in fact, as the reality that any living creature really is.

At night the sea of stars overhead slowly changed as they entered more and more into the Torrid Zone, and the immense constellation of the ship and the phosphorescent clouds of Magellan arose on the horizon—"we saw distinctly for the first time the Southern Cross on the night of the 4th of July, in the sixteenth degree of latitude—on that night I experienced the realization of one of the dreams of my early youth. . . . The two great stars which mark the summit and the foot of the Cross having the same right ascension, it follows that the constellation is almost nearly perpendicular at the moment when it passes the meridian. This circumstance is known to the people of every nation situated beyond the tropics, or in the southern hemisphere. It has been observed at what hour of the night, in different seasons, the Cross is erect or inclined. It is a time-piece which advances very regularly four minutes a day, and no other group of stars affords to the naked eye an observation of time so easily made. How often have we heard our guides exclaim in the Savannahs of Venezuela, or in the desert extending from Lima to Truxillo, 'Midnight is past, the Cross begins to bend.' "

The island of Tobago, breasting the north equatorial current, loomed above the early-morning fog a week later. The ship avoided Trinidad, which the English had taken from Spain two years before, crossed the shoal-water between Tobago and Grenada, and turned south toward the American mainland—"when we were five leagues distant from the coast we felt, near Punta de la Boca, the effect of a particular current which carried the ship southward. We cast the lead, and found from thirty-six to forth-three fathoms on a bottom of very fine green clay. According to the rules established by Dampier, we ought not to have expected so little depth near a coast formed by very high and perpendicular mountains. We continued to heave the lead till we reached the Cape Three Points of Columbus, and we everywhere found shallow water, apparently indicating the prolongation of the ancient coast."

At daybreak two days later the mountains of New Andalusia, half veiled by mists, rose above the southern horizon, and the city and castle of Cumaná appeared between groves of sixty-foot cocoa trees. Here they came to land, and science and the tropics stood hand in hand—Humboldt representing the essence of European civilization and scientific knowledge; South America, a vast experiment of Nature ripe for analysis.

The first weeks at Cumaná were employed in testing instruments and in collecting and pressing the plants of the region. Before they returned to Europe, Bonpland was to have discovered six thousand plants new to science, which I suppose is not too surprising, considering he was the first professional botanist to enter South America since Linnaeus first put botany on a systematic basis.

Travellers have always been inclined to under-estimate the intelligence and natural curiosity of a community remote from what is thought to be the centre of civilization. One of the most surprised persons I know was a botanist who visited the French-speaking black republic of Haiti and came back with the report that he had never in Europe or America met such an intellectually active and intellectually hungry group of men as the dark-skinned scientists of Port-au-Prince.

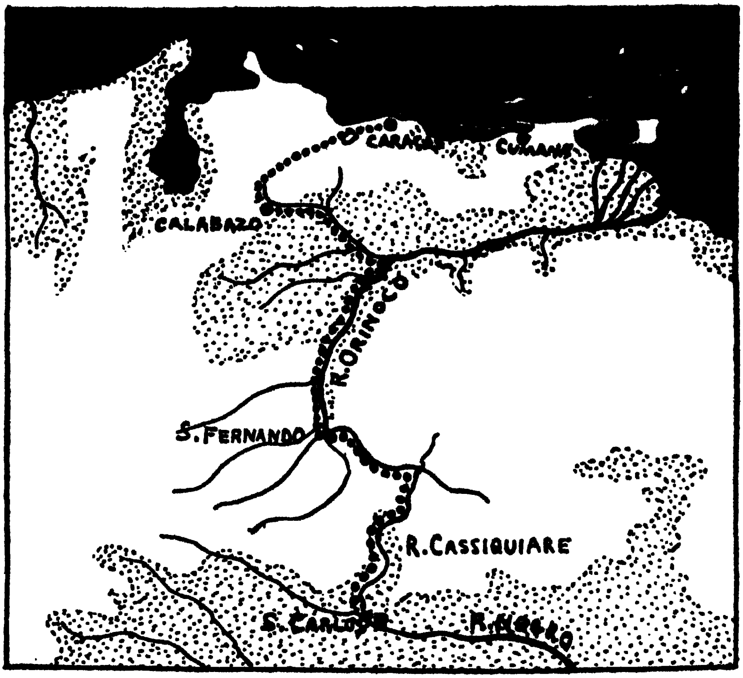
Humboldt was no less startled and pleasantly excited at his reception by the Spanish colonists at Cumaná and elsewhere, "whilst every surrounding object was fitted to inspire in us the most lively interest, our physical and astronomical interests in their turns excited strongly the curiosity of the inhabitants. We had numerous visitors; and in our desire to satisfy persons who appeared so happy to see the spots of the moon through Dolland's telescope, the absorption of two gases in a endiometrical tube, of the effects of galvanism on the motions of a frog, we were obliged to answer questions often obscure, and to repeat for whole hours the same experiments. These scenes were renewed for the space of five years, whenever we took up our abode in a place where it was understood that we were in the possession of microscopes, telescopes, and electrical apparatus." Yet there was another side to the picture, for while "our house at Cumaná was highly favourable for the observation of the stars, it obliged us to be sometimes the witnesses of painful scenes during the day. A part of the great square is surrounded by arcades, above which is one of those long wooden galleries, common in warm countries. This was the place where slaves, brought from the coast of Africa, were sold. The slaves exposed to sale were young men from fifteen to twenty years of age. Every morning cocoa-nut oil was distributed among them, with which they rubbed their bodies, to give their skin a black polish. The persons who came to purchase examined the teeth of these slaves, to judge of their age and health; forcing open their mouths as we do those of horses in a market." But after dark along the river where the earth was covered with sesuvium and mimosa, and the cool darkness alive with the flashing of fireflies, "we saw bonfires kindled by the negroes. A light and undulating smoke rose to the tops of the palm-trees and imparted a reddish hue to the disk of the moon. It was on a Sunday night and the slaves were dancing; to the music of the guitar."

Reorganized, with all instruments checked and tested, and with all the time in the world, the two naturalists left Cumaná and came to Caracas, their real point of departure. Midwinter was none too good for astronomy, for the clear light of morning gave way to cloudy evening skies, and only the local theatre saved the day. This was in the Caracas of 1800, for that city was suddenly and completely destroyed by earthquake a few years afterwards. The theatre was partly open, the women sitting in the covered section, the men in the open pit, where Humboldt was able to watch either the actors or the stars. If the sky remained misty, he saw the play; if it cleared, he went for his telescope and watched the satellites of Jupiter. Yet tropical spring comes early, and at the end of the first few weeks of the nineteenth century Humboldt and Bonpland left Caracas on their long journey into the heart of the continent.

The journey from Caracas took them south over the high Venezuelan plain to one of the north-western tributaries of the Orinoco, alternately through dry, stony country and rich woodland and forest and lakes. And in this now-distant year of 1800 Humboldt was already alarmed at the creeping consequence of forest destruction, of ensuing climatic change, lack of water and fuel, as sugar, indigo, and cotton replaced the great fig trees and mimosas of the lands around the lakes. The most popular sugar-cane grown in the new plantations was and still is known as the Otaheite cane, which de Bougainville brought back from Tahiti in 1777 to the island of Bourbon. It took but a few years for planters to bring it to the West Indies and the mainland colonies, where it quickly supplanted the older "creole" cane introduced by Columbus on his second voyage.

"From a peopled country embellished by cultivation, we plunge into a vast solitude. Accustomed to the aspect of rocks, and to the shade of valleys, the traveller beholds with astonishment these Llanos or savannahs without trees, these immense plains, which seem to ascend to the horizon . . . in the rainy season they are covered with verdure, but in the time of great drought they assume the aspect of a desert. The grass is reduced to powder; the earth cracks; the alligators and great serpents remain buried in the dried mud till awakened from their long lethargy by the first showers of spring—often within a distance of thirty square leagues there is not an eminence more than a foot high. This resemblance to the surface of the sea strikes the imagination most powerfully where the plains are altogether destitute of palm trees, and where the mountains of the shore and of the Orinoco are so distant that they cannot be seen.

"In order to escape as much as possible from the heat of the day, we set off at two in the morning, with the hope of reaching Calabozo before noon, a small but busy trading town, situated in the midst of the Llanos. The aspect of the country was still the same. There was no moonlight; but the great masses of nebulae that spot the southern sky enlighten, as they set, a part of the terrestrial horizon. The solemn spectacle of the starry vault, seen in its immense expanse;—the cool breeze which blows over the plain during the night:—the waving motion of the grass, wherever it has attained any height; everything recalled to our minds the surface of the ocean." The rising sun only increased the illusion, until the morning heat and gusts of dusty air brought them to earth. Even then the mind was active—"Why does not the great forest of the Orinoco extend to the north, on the left bank of that river? Why does it not fill that vast space that reaches as far as the Cordillera of the coast, and which is fertilized by numerous rivers? These questions are connected with all that relates to the history of our planet. It is more



difficult to explain the origin of the bare savannahs, encircled by forests, than to recognize the causes that maintain forests and savannahs within their ancient limits, like continents and seas." With the burning plain about them, their thoughts engrossed with the scene, and their heads covered by hats stuffed with leaves to ward off the heat, they came to the small town of Calabozo and the surprise of their lives.

You need, I think, to see Calabozo on a map to feel in full its isolation, cut off by mountain ranges from the coast and by eight hundred miles of river from the mouth of the Orinoco. How could news of current intellectual advances in Paris, London, or Philadelphia reach into the scorched lands of the headwaters? I cannot improve on Humboldt's own account of what they found amidst the cordial hospitality of a cattle-farming settlement: "We found at Calabozo, in the midst of the Llanos, an electrical machine with large plates, electrophori, batteries, electrometers; an apparatus nearly as complete as our foremost scientific men in Europe possess. These articles had not been purchased in the United States; they were the work of a man who had never seen any instrument, who had no person to consult, and who was acquainted with the phenomena of electricity only by reading the treatise of De Lafond, and Benjamin Franklin's memoirs. Señor Carlos del Pozo, the name of this enlightened and ingenious man, had begun to make cylindrical electrical machines, by employing large glass jars, after having cut off their necks. . . . Till now he had enjoyed only the astonishment and admiration produced by his experiments on persons destitute of all information, and who had never quitted the solitude of the Llanos; our abode at Calabozo gave him a satisfaction altogether new. . . . I had brought with me electrometers mounted with straw, pith-balls, and gold leaf; also a small Leyden jar which could be charged by friction and which served for my physiological experiments. Señor del Pozo could not contain his joy on seeing for the first time instruments which he had not made, yet which appeared to be copied from his own. We also showed the effects of the contact of heterogeneous metals on the nerves of frogs. The name of Galvani and Volta had not previously been heard in those vast solitudes." After all, it was wonder enough that Franklin was there, in spirit at least, working in a little lost and overheated town lying between the banks of the Guarico and Urituca.

The greater interest of Calabozo, however, was not the Spaniard but the electric eel. Humboldt had been attempting to get one alive and in good condition ever since his landing at Cumaná, but without success. All he had obtained along the coast were not eels but the torpedo ray, which gave only feeble shocks from electric organs visible through its more or less transparent skin. Even at Calabozo the Indians were too scared of the fish to bring any into the town, so that one fine March morning at a very early hour Humboldt, Bonpland, and no doubt the Señor Carlos set off for an Indian village where there was a stream which in time of drought formed a basin of muddy water surrounded by mimosa and other fragrant flowering trees. Nets were useless, as the eels speedily buried themselves in the mud, and the Indians said they would "fish with horses". This consisted in a preliminary scouring of the savannah for wild horses and mules, of which they took about thirty, and driving them into the pool. The extreme disturbance caused by the horses' hoofs made the fish leave the mud and, like yellowish and livid aquatic serpents, drive along the surface of the water to the attack. The eels pressed all their five-foot length close to the bellies of the horses and discharged their batteries, more or less stunning the horses, so that they could hardly stand. Two horses were drowned within five minutes, in the turmoil of discharging eels and panic-stricken mammals, but the eels eventually tired of the excitement and were taken without much difficulty.

Humboldt's first experiment on the eel were a little more direct than is customary in physiological investigations. Imprudently he placed both feet on an eel just taken out of the water and received a more dreadful shock than any he had ever received from a large battery, and for the rest of the day suffered violent pain in the knees and in almost every other joint. At every shock, which lasted two or three seconds, he felt an internal vibration of his muscles, followed by painful numbness, an effect quite different from the shocks he was used to getting from his Voltaic batteries. Yet he concludes, and accurately, that the electricity is the same, but the manner of discharge is different. One eel was dissected, to find that more than two-thirds of the animal's body consisted of the electrical organs and only the front third was truly fish! The electric tissue lay as closely packed plates along each side of the body, a regular battery style, taking the place of what is normally masses of the muscle of the tail. In this matter of electricity and living tissues we run headlong into the deepest nature of organisms and life, and I am not at all sure our understanding is even now much more profound than was Humboldt's. The mystery deepens as the information piles up.

What Humboldt and Bonpland did discover was that the control of the discharge centred in the brain and that the control was precise, that the discharge could in some degree be localized, and that it could be violent, moderate, or weak. And recent research backs him up: an electric wave of one ampere with a 400- to 500-volt impact runs along the organ at the rate of a thousand yards a second, ten times as fast as a nerve impulse travels down to my hand; and the organ actually is a group of three different sets on each side of the body, each with its own kind of discharge, each with its own particular communication with the brain. Many men have wondered about the eel and have questioned it with all their ingenuity, but the questions are answered, as all true questions are, with greater questions.

"We left the town of Calabozo on the 24th of March, highly satisfied with our stay, and the experiments we had made—and as we advanced into the southern part of the Llanos, found the ground more dusty, more destitute of herbage, and more cracked by the effect of long drought. The palm trees disappeared by degrees." Three days later, after nights spent in hammocks over which hovered enormous vampire bats, intent, it seemed, on fastening upon their faces, they arrived at the Villa de San Fernando, the termination of the journey across the llanos. Humboldt ceases to be the physiologist and becomes outright explorer.

18

THE SEA IN THE JUNGLE

San Fernando was a Capuchin missionary town newly established near the white, sandy shores of the Apure River, one of the greater branches of the Orinoco. At the time of their arrival the dry season was about to end and the heat was terrific. In the wet season, they heard, the savannahs of this region became covered with twelve or fourteen feet of water, and farms and villages then stood on shoals no more than two or three feet above the water. Apure, Meta, and Orinoco all swell with the rains, overflowing into the great basin, and it was a common sight to see mares, followed by their colts, swimming to feed upon the top of the grass waving above the water. The colts drowned everywhere, in large numbers, and even the mares survived only by virtue of longer legs and in spite of the crocodiles that pursued them. As the rivers return to their beds, the savannah is overspread with a beautiful scented grass, and for a while the joys of spring are universal.

A day or two of San Fernando were more than enough, although one of them was memorable. At sunrise, with thunder rolling from all directions and the first rain of the season falling, long files of porpoises began to play along the surface of the Apure, to the alarm of the slow and indolent crocodiles, who dived for the bottom whenever they came too close.

Humboldt, Bonpland, and the brother-in-law of the provincial governor, newly arrived from Cadiz, departed from San Fernando in a large Indian canoe so spacious that it carried a crew of four paddlers, a pilot, and a palm-thatched cabin containing table and benches. In such style did they travel down the Apure River to its junction with the

Orinoco, with thorny jungle on either side, through which came jaguars, tapirs, and peccaries to drink. Crocodiles lay stretched on the sand between the river and the jungle, although, with the rainy season hardly begun, hundreds still remained buried in the mud of the savannahs. Those of the Apure fed upon the capybaras, the largest rodents in the world, as big as the largest dog, that lived in droves of fifty or sixty together along the banks of the river, feeding on the river weeds. At times the canoe was surrounded by the giant guinea-pigs, for that is what they are, and they survive the assault of the jaguar by land and the crocodile by water only through guinea-pig fecundity, for they have no means of racial defence except taking to water and remaining submerged, according to Humboldt, for eight or ten minutes. They were sometimes called blunt-nosed tapirs because of this liking for water and clumsiness on land, though no two mammals could be much more distantly related. The real tapir, with its tapering mobile nose, shortsightedness, and shape and size like a cross between a pig and a rhinoceros, is closer kin to a horse. Only, like the capybara, it is as much at home in the head-waters of the South American rivers as any animal could be without gills, fins, or flippers. Natives believe it walks submerged on the river bottoms, but so little of it shows above the water when swimming that probably it is simply overlooked.

Porpoises still ploughed the river in long files, as out of place as a sailor in Denver, flocks of parakeets shrieked past, pursued by little whistling goshawks, and at one point the canoe passed a low island crowded with thousands of flamingos, rose-coloured spoonbills, herons, and moorhens—so close together that they seemed unable to stir. At night, on shore, a fire was lit, with difficulty, for the forest was impenetrable and dry wood hard to find. "The night was calm and serene, and the moonlight was beautiful. Crocodiles, stretched along the shore, placed themselves so as to be able to see the fire. Finding no trees on the strand, we stuck our oars in the ground, and to these fastened our hammocks.

Everything passed tranquilly until eleven at night, and then a noise so terrific arose in the neighbouring forest that it was impossible to close our eyes. There were the little soft cries of the sapajons, the moans of the alouate monkeys, the howling of the jaguars and couguars, the peccary, and the sloth, the cries of the curassoo, the parraketes and other birds . . . the Indians said—'They are keeping the feast of the full moon.' "

Humboldt had a different answer, and thought the jaguars pursued the peccaries, which crashed in panic through the bushes, alarmed the monkeys in the tree-tops, and created general pandemonium. There was no silence in the forest at night, and long-tailed bats and sharp-nosed insects made disturbance doubly real.

During the last evening on the Apure the canoe passed the Cano del Manati, so named on account of the immense numbers of manatees caught there every year. Humboldt saw them in all the branches of the Orinoco and succeeded in dissecting one of these ten-foot, 600-pound mermaids. Unlike those Columbus saw in the Caribbean, these showed no trace of nails on the edge of the fins, and were not so large. Otherwise a manatee is a manatee, and looks like a mermaid or a sea-cow, according to your traditions and disposition: two species in the Americas, one in Africa, three in the East Indies, if you include the dugong, and one—the largest of all—Steller's sea-cow which used to frequent the shores of Bering Strait.

All manatees are easily caught, for they are slow-witted vegetarians that rely more upon bulk than speed to avoid destruction, apart from a certain invisibility in the water resulting from a blotched and dusky colour. It is a curious animal, streamlined and almost hairless, with only paddle-like fore-limbs present. Not only are there no hind-limbs but there is hardly a trace of the pelvis to which they were once attached. In their own way they are as aquatic, and as warm-blooded, as whales and porpoises, with a propelling tail blade that is vertical instead of horizontal. And, like the whale, they are full of oil and fat, called manatee butter, used in food and for lamps in the churches along the river. Even the Indians are perplexed, for they cannot understand why an animal living in water and resembling a fish should suckle its young. Humboldt and Bonpland, in dissecting it, were greatly impressed both by the enormous length of the intestine—more than one hundred feet—by the subdivision of the stomach into compartments, both features, however, being typical of purely plant-eating mammals, especially those which chew the cud, which suggests something of the manatee's ancestry.

Manatee butter troubles me. I have always assumed that the large amount of blubber and oil in porpoises and whales, seals and penguins, served primarily as insulation against loss of body heat. A seal lying on an ice-pan makes no impression; its warmth is kept within and no ice melts. The fat, of course, is also an energy reserve, and its thickness in seals and whales changes with the seasons. Eskimos who use rifles instead of harpoons lose two out of every three seals that they shoot in summer-time because the bodies sink so fast. So buoyancy, too, comes into the blubber picture, and it may be important, for it is uneconomical to waste effort in just keeping afloat. But all this concerns warm-blooded, meat-eating mammals and birds that have gone back to the sea for their livelihood. It's the manatee that stands out like a sore thumb.

Manatees and dugongs are not flesh-eaters but are confirmed vegetarians, and they only venture to sea on excursions along the shore for seaweed or to get from one river-mouth to the next. Their fossils suggest that they were more marine at one time and fed more upon the seaweed along the edge of warm and shallow seas. But they stayed close to shore, close to their source of food. And they lived in tropical seas, warmer than those we have now. Whether they first became aquatic in the great rivers and estuaries is not so certain, but it is probable, for vegetarian quadrupeds are inclined that way. Why it was so important to become streamlined as a swimmer is less clear, unless it was the better to avoid the crocodiles or sharks, or to get weed at a greater depth than a regular four-legged creature could reach. If there is any truth in all this, and manatees really are products of tropical waters, why should they contain so much fat?

It can't be for warmth, and with a steady supply of food there is little need for reserves—it may have something to do with buoyancy in the water, or perhaps it is concerned with shape. If quick movement through water is important, it probably has been so from the beginning, and there are few animals so badly shaped for swimming as the average quadruped. The change to fish-like form is difficult and age-consuming, anything that speeds up the process would have been invaluable, and the shortest route to a more streamlined shape is fat. Fat can be moulded in far fewer generations than it takes for muscle and bone, and sleek contours may depend more upon the use of blubber than we think. After all, it has worked with the maid and should work for the mermaid; Nature covered both with fat and patted it into shape. It's an appealing thought and is not so crazy as it sounds.

Hammocks were about to be slung from the trunk of a locust tree near the Bay of Manatees when a couple of large-spotted jaguars slunk out from behind it. So the travellers pushed on to a small island and in the day that followed found the Orinoco.

The river stretched before them as an immense plain of water, with white-topped waves as far as the eye could reach. Long-legged water-birds no longer flew from one side to the other and only a few large crocodiles cut obliquely across the waves with their long tails. And, instead of continuing downstream, as on the Apure, they turned south-west along the shore, the fresh north-east breeze carrying them full sail up the Orinoco to the Boca de la Tortuga, an island celebrated for its turtle fishery.

Humboldt arrived at the critical moment, for the egg-laying of the turtles takes place at the very end of the dry season—and on the island were some white traders, and more than three hundred natives, all assembled for the "cosecha", the annual harvest of the eggs. A Franciscan monk stood by to supervise the proceeding; his chief duty was to select assistants to help determine the extent of the sand which contained eggs and to divide it among the various Indian families present. Two kinds of turtles laid their eggs along the beaches: fresh-water terrapins, with neither stumpy feet like the tortoise nor flippers like the sea-turtle, and more or less giants among their kind, forty or fifty pounds apiece. Just before the eggs are laid the turtles gather around the islands in unbelievable numbers and inspect the shore with an eye to safety, and then, for the most part between midnight and dawn, they stumble slowly to a site well above the waterline and set to work—each to excavate pits two to three feet deep in which to lay about one hundred good-sized eggs. Only the females come ashore, but in such numbers that many dig their holes where eggs have already been laid.

Neither turtles nor Indians have changed much, and as soon as a sand-bar is divided the natives start excavating, each family digging with its hand until at the end of the second day it has a mound of eggs four or five feet high. Some are eaten then and there, others dried for future use, but most are squashed and poured with water into a wooden trough to bake in the sun until the oil comes to the top. This is skimmed off and boiled for use in cooking or for lamps, like the manatee butter. The amount of oil produced is the best indication of the number of turtles there must be in the South American river. Humboldt found that the three islands he encountered yielded about five thousand jars, that it took five thousand eggs to fill a jar, and that a third of the eggs were broken when laid, so that the harvest consisted of more than thirty million eggs. At one hundred apiece, more than three hundred thousand females must have been busy laying them, and this could have been but an insignificant proportion of the total turtle population of the river systems. Above all else it is turtle territory, and remains so to this day.

In spite of the egg-harvesting, the turtles seem to be as abundant as ever, and this is also in spite of the jaguars, crocodiles, herons, and vultures that feast on the babies as they struggle out of the nests on to the sand above. Though hatching may have occurred during the day, emergence above-ground always takes place at night, which is just as well, for the temperature at the sand surface under the hot equatorial sun Humboldt found to be as high as 150° F. Young turtles attempting to reach the water during the day turned red, shrivelled, and died before covering ten yards. Sometimes eggs are laid a mile away from the river, and it is a peculiar instinct that drives the newly hatched reptiles through the darkness toward the water, usually by the most direct route. Baby sea-turtles have a blue horizon to aim at, but the fresh-water terrapins manage without such a guide, and leave us in wonder with no good answer. If they are picked up and turned around, they regain their right direction.

Leaving Tortuga Island, loaded with little live turtles and sun-dried eggs for use of the native crew, they set sail once more, only to overturn in the squally wind, though without serious consequence—"to the reproaches that were heaped upon the pilot for having kept too near the wind, he replied with the phlegmatic coolness peculiar to the Indians, observing 'that the whites would find sun enough on those banks to dry their paper' "—and in less than an hour were off again. The river was here nearly five miles across, though six hundred miles from its mouth. Gradually it narrowed and the current increased. High and wooded banks and gusty wind made sailing ever more difficult, but at last, after passing between the high cliffs of the Strait of Baraguan, they came to Pararuma, where the pilot informed them that that was as far as he and his boat could take them.

Even in the blazing heat of the noonday sun, when a thermometer placed against the rocks rose to 120° F., Humboldt felt the pulsing throb of Nature—"all the stones were covered with an innumerable quantity of iguanas and geckos with spreading and membranous fingers. These lizards, motionless, with heads raised and mouths open, seemed to suck in the heated air. The soil appeared to undulate, from the effect of the mirage, without a breath of wind being felt. The sun was near the zenith, and its dazzling light, reflected from the surface of the river, contrasted with the reddish vapours that enveloped every surrounding object.—The beasts of the forest retire to the thickets; the birds hide themselves beneath the foliage of the trees, or in the crevices of the rocks. Yet amidst this apparent silence we hear a dull vibration, a continual murmur, a hum of insects filling all the lower strata of the air.—Myriads of insects creep upon the soil, and flutter round the plants parched by the heat of the sun. A confused noise issues from every bush, from the decayed trunks of trees, from the clefts of rocks, and from the ground undermined by lizards, millipedes, and worm-salamanders. All nature breathes, and under a thousand forms life is diffused throughout the cracked and dusty soil, in the waters, and in the air about us."

Fortunately, at Pararuma they were able to purchase a good canoe, and the missionary to the cataract country offered to go along with them as guide. "The new canoe intended for us was, like all Indian boats, a trunk of a tree hollowed out partly by the hatchet and partly by fire. It was forty feet long, and three broad. Three persons could not sit in it side by side. When you want to rise for an instant, you must warn the rowers to lean to the opposite side, otherwise the water would enter the side pressed down. It is difficult to form an idea of the inconveniences that are suffered in such wretched vessels. . . . To gain something in our new canoe, a sort of lattice-work had been constructed on the stern with branches of trees. Unfortunately the roof of leaves was so low that we were obliged to lie down, without seeing anything, or, if seated, to sit nearly double. The necessity of carrying the canoe across the rapids, and even from one river to another; and the fear of having too much hull to the wind by making it higher, render this construction necessary for vessels that go up towards the Rio Negro.—The fore part of the boat was filled with Indian rowers, furnished with paddles, three feet long, in the form of spoons. They were all naked, seated two by two, and they kept time in rowing with a surprising uniformity, singing songs of a sad and monotonous character. The small cages containing our birds and monkeys, the number of which augmented as we advanced, were hung some to the branches and others to the bow of the boat. This was our travelling menagerie. . . . There remained no other place for the dried plants, trunks, a sextant, a dipping needle, and the meteorological instruments, than the space below the lattice work of branches, on which we were compelled to remain stretched the greater part of the day. To these inconveniences were joined the swarms of mosquitoes and the heat." In this manner they made their way up the swelling Orinoco to Carichana.

This was a place where the river had apparently forced its way through mountains and Humboldt was puzzled to find black bands and erosion lines one hundred and more feet above the already swollen river, indicating ancient levels of the water.

At this point in his *Personal Narrative*, Humboldt stops to speculate, although in the light of his somewhat later American journeys, and for the first time we find a strong sense of the past earth and past life. "Is then the river, which appears to us so grand and so majestic, only the feeble remains of freshwater which heretofore traversed the country at the east of the Andes, like arms of inland seas? What must have been the state of those low countries of Guiana that now undergo the effects of annual inundations? What immense numbers of crocodiles, manatees, and boas must have inhabited these vast spaces of land, converted alternately into marshes of stagnant water, and into barren and fissured plains! . . . The bones of mastodons and American elephants are found dispersed on the table-lands of the Andes. The giant sloth inhabited the plains of Uruguay. On digging deep into the ground, in high valleys, where neither palm trees nor arborescent ferns can grow, strata of coal are discovered, that still show traces of gigantic monocotyledonous plants. There was a remote period then, in which the classes of plants were otherwise distributed, when the animals were larger, and the rivers broader and of greater depths. There end the records of nature, that it is in our power to consult." Here is the beginning of the sciences of historical geology and the history of animals.

Leaving Carichana the course of the river became more and more blocked by great granite rocks, until the channels became so narrow that the canoe had to be warped along with ropes. The waters of the great Orinoco seemed almost to disappear among the piled rocky chaos, and even the crocodiles seemed to shun the noise of the cataracts. Later the canoe with its vulnerable and precarious freight reached the junction of the Orinoco with its tributary the Meta, itself the union of two rivers.

From the Meta onward, the journey up the Orinoco became increasingly one of paddling against tumultuous waters, hauling between rocks and portaging around cataracts, with so many tributaries joining in it that it became difficult at last to say which was the Orinoco itself. Humboldt was not concerned with tracing the mighty river to its source, and in fact it was only in 1951 that another expedition pressed into the dank forest beyond the limit of Humboldt's journey, supported by parachuted supplies, to measure the various streams of the Parima Mountains in an attempt to discover which is the largest. It is still one of the world's last frontiers. Humboldt had a different objective, which was to confirm his belief in an old report that there was a navigable connection between the Amazon and the Orinoco. Instead of ascending the river directly to Esmeralda, the base of the recent expedition, he turned aside at San Fernando at the head of the great cataracts—"during the night, we had left, almost unperceived, the waters of the Orinoco; and at sunrise found ourselves as if transported to a new country, on the banks of a river the name of which we had scarcely ever heard pronounced and which was to conduct us, by the portage of Pimichin, to the Rio Negro, on the frontiers of Brazil. If it had not been for the Franciscan missions he would not have succeeded, and now that they are no more travel in this region is much more difficult. 'You will go up', said the president of the missions, who resided at San Fernando, 'first the Atabapo, then the Temi, and finally the Tuamini. When the force of the current of "black waters" hinders you from advancing, you will be conducted out of the bed of the river through forests, which you will find inundated. Two monks only are settled in those desert places, between the Orinoco and the Rio Negro; but at Javita you will be furnished with the means of having your canoe drawn over land in the course of four days to Cano Pimichin. If it be not broken to pieces you will descend the Rio Negro without any obstacle as far as the little fort of San Carlos; you will go up the Cassiquiare, and then return to San Fernando in a month, descending the Upper Orinoco.'" Such was the plan, and he carried it out in thirty-three days. From San Carlos he might have gone on down the Rio Negro, into Portuguese territory, and so down the length of the Amazon, though it was well that he did not, since his presence was already known and his motives suspected, and only jail awaited him.

On the way, near the junction of the Temi and the Tuamini, they left the bed of the river and proceeded in their canoe southward across the forest through channels four or five feet broad, in water rarely more than three feet deep. "An Indian, furnished with a machete stood at the head of our boat, employed continually in chopping off the branches that crossed each other from the two sides of the channel. In the thickest part of the forest we were astonished by an extraordinary noise. On beating the bushes, a shoal of toninas or fresh-water dolphins (porpoises) four feet long, surrounded our boat. They fled across the forest, throwing out those spouts of compressed air and water which have given them in every language, the name of 'blowers'. How singular was this spectacle in an inland spot, three or four hundred leagues from the mouths of the Orinoco and the Amazon!"

Humboldt was amazed, and no wonder. I can think of few animals more marine than a whale, whether or not the whale is small and goes by some other name, and few places on this earth seem more remote from the ocean than the flooded forest floor of a raised watershed a thousand miles from the sea. No simile comes to mind which can sharpen the contrast or the incongruity of tiny whales sporting in little more than knee-deep water beneath green and flowering vines in tropical jungle. Humboldt himself speculated on how they succeeded in reaching such remote territory, and favoured a passage from the sea by the Amazon route, feeling that the Orinoco cataracts would have been too formidable a barrier. He also thought they were, as he says, like those of the Ganges, of a species essentially different from the dolphins and porpoises of the ocean. This is true enough, but the problem becomes more difficult.

There are fresh-water porpoises or dolphins (the name does not matter except that in the sea both a fish and a porpoise are called dolphin, which is confusing) not only in the Amazon and Orinoco water-ways and in the Ganges of India but also in the Indus, in the Rio de la Plata, and six hundred miles up the Yellow River of China in Tungting Lake. We might think that a wide river-mouth with plenty of fish upstream would be enough of a temptation and that dolphins or porpoises simply have left the sea wherever the reward has been great enough and have become a little different from their ancestors in the course of time.

Yet the picture is more puzzling. While each great river has its own particular kind, except that in India the Ganges and Indus have but one between them, they all differ from their marine relatives in the same considerable ways—they all have eight pairs of double-headed ribs in place of four, have neck vertebrae separate from one another instead of fused, have a less compressed skull, and so on. It amounts to this, that all the fresh-water dolphins belong to one primitive family of whales, possibly more primitive than any other now living; none of them are found in the sea, but at the same time they are scattered in the rivers around the world that have no connection with one another except by sea. Now it's your turn to worry about it.

Thus Humboldt and Bonpland came to Javita and made the Pimichin portage through a snake-infested marsh with no more casualty than the loss of much of the botanist's plant collection through excessive humidity, to come at last to the Rio Negro, the great tributary to the Amazon. In May they left the border fort of San Carlos, which was their turning point, went up the Rio Negro to the mouth of the Cassiquiare, and for ten days paddled against the current of that amazing little river, leaving black water for white, cloudy skies for starry nights, and for more mosquitoes and crocodiles. When they reached the end of the Cassiquiare and found themselves entering the Orinoco again, they had added to their already overcrowded canoe a toucan, seven parrots, "two manakins, a motmot, two guans, two manavirois, eight monkeys and a short-tailed cacajao". I am uncertain what animals some of these are, but the general effect under the circumstances is hard to imagine.

They re-entered the Orinoco about ten miles below the mission of Esmeralda, which they visited long enough to watch the Indian poison-master prepare curare, the deadly paralytic poison of arrow-tips which is now an important drug, and to discover that you do not walk in the forests without a shield of very hard wood over head and shoulders, for this was the land of the Brazil nut, and the huge nut-cases could kill a man if one fell on him. When at last they started downstream the voyage was swift and it was a relief to leave a land to which monks were sent as a punishment to be eaten alive by mosquitoes.

So ended the first journey. Humboldt's second and last expedition in South America started the following year from Cartagena, and both he and Bonpland travelled by mule across the Andes to Quito, the capital of Ecuador. Most of the time was spent climbing and studying the great mountain peaks, and included close acquaintance with the condor. For the rest, he travelled along the coastal desert, studied the guano deposits of the Peruvian islands, and arranged for the first guano shipments to Europe as fertilizer; and, not least, discovered the cold distinction of the Peruvian Current, which now bears his name as the Humboldt Current on all maps of the Eastern Pacific. On the way home, after a year in Mexico, he stopped in Virginia for a memorable four-day visit at Monticello with Thomas Jefferson. Following his return to Europe, Humboldt became, after Napoleon, the most celebrated and honoured person on the Continent, a prestige he kept until his death half a century later. But a few years after he had left the Americas, New Spain blew up in revolt, and the two naturalists became the first and last educated foreigners to see the Spanish conquests in their colonial status. Yet they described the life and land of the new tropics so faithfully and vividly that others have ever since been drawn to the great rain-forest to see for themselves.

19

THE PURPLE LAND

WITH THE dawn of the nineteenth century, natural history, the mother of all our present biologies, becomes a science. It is more difficult to see animals and plants clearly and objectively than to contemplate the stars, or salt, or even heat and heaviness. There are several reasons, it seems to me, for this. A living organism is by far the most complex thing in the universe that as yet we are aware of, and even the simplest is infinitely difficult to comprehend—the diversity of life is itself overwhelming and the welter of facts is hard to pull together—and not least, our own senses and emotions are so wrought up with other living beings, animal or vegetable, that our feelings about them get in the way of objective thinking.

This is why the biological sciences in a way lag behind the physical and chemical, and you see the same thing reflected in the age at which a man is most creative. In the mathematical realm of physics or astronomy the peak is reached in the twenties—Newton said he was at his best at twenty-three. In chemistry, inorganic or biological, the peak comes usually in the thirties, which it did for Lavoisier and most of his successors. But in the natural history group of sciences the peak comes late, and a man as a rule is in his forties before things begin to click. It is not, I think, that one mind is better than another, although different things appeal to different minds, and creation comes only when the appeal is irresistible, but rather that it is a case of needing more time for the biological facts to sink in. For a mind can only play with what it has fully digested, and it takes time and more time for that digestion to be effective. Which brings me to something else. A naturalist, or a biologist or zoologist, whatever you like to call him, needs half of his life to accumulate and assimilate enough information about living organisms to be sure of a fair sampling. If he is not by then already weary or worn out he has enough toys in his mental nursery to play with for the rest of his life. And I doubt if anyone has more fun in the long run—and this mental playing around with facts and images, wondering about them at any time of the day or night, is fun. And the more fun it is the more likely something creative will come out of it and, according to the record, the longer you are likely to live! Humboldt kept going till he was ninety; in fact, as a youngster of seventy he conducted a nine thousand-mile scientific expedition to the Ural Mountains of Asia. He was eighty when he began to publish *The Cosmos*, eighty-nine when he finished his work, which was no less than a five-volume *Sketch of a Physical Description of the Universe.* When it was completed and received by his world, he died, for all that the man was had been fully expressed, and there was nothing left to be done or to wait for.

If Humboldt never felt a moment's queasiness at sea, his successor, Charles Darwin, never felt a moment's peace. In 1831, as a young man of twenty-two, he left England as naturalist on board a warship, HMS *Beagle*, on a journey that, like Humboldt's, lasted five years. The greater part of the voyage was a protracted circumnavigation of South America which gave him opportunities for landings and journeys into the interior, into both southern Patagonia and the pampas country from the east and at various places along the Pacific coast. This was the experience which was to culminate in *The Origin of Species* more than twenty years later. Humboldt lived to see it published. When you consider the training of the two men, why was it Darwin who saw so far beneath the surface?

Humboldt had had the finest education the continent of Europe could offer and had spent an additional ten years specifically preparing to make the most of his planned adventure; took to it a mature mind and all the information and means he could muster. Was it too soon, or did he know too much? Too much knowledge can be a barrier to vision, yet more than likely he was a little too early. Great ideas were slowly simmering in the cauldron of men's minds, and no man goes forth except in his own time, prepared by all that he has encountered. Darwin, by comparison, received no more than a fair formal education, was an indifferent student, and had failed in medical school. He went on to Cambridge to study for the ministry, while his father, a country doctor, shook his head in grave misgiving. He was offered the chance to go on the *Beagle* almost by default, for few men more senior could afford to spend several years without financial reward.

I think we have here another case of the distinction between formal and informal education. What really mattered was what Darwin did out of school, not in—there is every indication of a deep, active thinker going his own way, but without any satisfactory goal. Both Nature and men played their part. From a very early age he was an ardent collector of minerals, insects, and flowers, and a man or a boy thinks most about what most interests him. And as a youth he read Humboldt's *Personal Narrative* and dreamed of adding to its lustre. Yet, more than all of this, he was the grandson of his father's father, Erasmus Darwin, a man great in his own right, who had already formulated a theory of evolution of animals, who must have had some influence upon the thoughts and reflections of his grandson.

The young man who sailed on the *Beagle* was already tensed to the experience which lay before him, although he left England with an unshaken belief in the creationist point of view and the immutability of species. He believed that a species once created was, to use the words Louis Agassiz was to hurl at him many years later, "as final as an expressed thought". Perhaps I should say that his belief was unshaken because it never had been seriously challenged, for one of the outstanding qualities Darwin had throughout his life was a capacity to change his opinion as the evidence required, and a freedom from dogmatism, particularly in connection with his own conclusions. And no mind is worthy of the name if it is only a slate for others to write on.

The *Beagle* left Plymouth late in October, with its sea-sick naturalist on board and took the old course to the south to the Canaries and Cape Verde Islands and across to the bulge of Brazil. I mention the sea-sickness again because for five long years, apart from the trips ashore, Darwin never became accustomed to the motion of the vessel and suffered continual misery, which in some form afflicted him for the rest of his life. Humboldt would have enjoyed every minute of the voyage and would never have called the ship a floating prison!

It is pretty obvious that Darwin was not equipped to take full advantage of an expedition of short duration, and had it lasted much less than the five years he might never have found the key to the pageant of the past. That he did succeed, however, was no accident, for, as he says in his diary, he was afraid he would be quite overwhelmed with the number of subjects he ought to take in hand. He took along all the books he could collect in all branches of natural history, perhaps the most important being Lyell's *Geology*, a book that extended Humboldt's beginnings to the broad basis of a modern science. In the same entry of December 13, 1831, Darwin made his resolution to be steadily industrious throughout the voyage and hoped that with such an opportunity he would not muff his chances of drilling his mind, as he had at Cambridge.

Teneriffe was disappointing because quarantine restrictions prevented him from landing, and the ship continued to the Cape Verdes. Here we find him improving on the dip-bucket of his predecessors in an effort to capture the small drifting creatures of the sea surface, by towing a deep bag of bunting behind the vessel, an invention which has in later elaborations become the chief tool of biological investigations of the ocean. The short stay at the islands became ever more vivid as the contrast between the black and burnt volcanic rocks and the amazing beauty of living corals in the surrounding waters etched into his very being. From Cape Verde to Brazil only a landing on the bird-crowded St. Paul's rocks, the minute tip of a volcano arising from the mid-

Atlantic abyss, where no land should be, and an uncomfortable shaving by Neptune's barber when the ship crossed the line, marked an uneventful passage.

Landfall came at Bahia, and Darwin's first few walks in the Brazilian forest left him at a loss for words to describe it—if his eye followed a gaudy butterfly it was stopped by some strange fruit or tree, in watching an insect he forgot it in the stranger flower—he wrote that his mind was a chaos of delight, out of which a world of future and quieter pleasure would arise, and that only Humboldt, like another sun illuminating everything he beheld, was fit to be read.

Such landings were all too few and far between, although when the sea was quiet enough the ship became a marvellous place in which to study. After two weeks at Bahia the *Beagle* left on a southern survey of coasts and harbours, and apart from visits to Rio de Janeiro and Montevideo, Darwin was at sea for most of the time from March, 1832, until May of 1833. During this period he saw something of Tierra del Fuego and its miserable savage inhabitants, and visited the bleak and treeless Falkland Islands, neither of them for the last time. When finally the opportunity came for a three-month expedition inland through Patagonia, he was well girded for the adventure and knew his purpose better.

At the end of July, 1833, the *Beagle* arrived at the Rio Negro, the largest of the rivers between La Plata and the Strait of Magellan, and from here Darwin travelled across the plains of Patagonia to Buenos Aires and Montevideo.

At first the level plain, stretching as far as the eye could see, was covered with dry, gravelly soil, with only tufts of brown, withered grass and low, scattered, thorny bushes to save it from being completely desert. A solitary tree, visible from a great distance, served as a sacrificial altar to the Indians. The first night was spent under the open sky amid the deathlike stillness of the plain, with dogs keeping watch and a gypsy group of gauchos making their beds around the fire. Only the hare-like agouti was common, hopping in twos and threes in a straight line across the wild plains, though occasionally a wild llama, the guanaco—could be seen keeping its distance.

Desolation slowly gave way to plains covered with green turf, tall purple clover, and little owls, and even where the country deteriorated into a wide, level waste of sand, salt marsh or mud, ostriches, deer, cavies, and armadillos were abundant. Both Darwin and his guide watched the animals closely as they rode along, Darwin as a naturalist and the guide as a man who knew the danger of riding abroad while the war of extermination was still being carried on against the Indians by the Spaniards. At last, however, they "rode on in peace and quietness to a low point called Punta Alta, whence we could see nearly the whole of the great harbour of Bahia Blanca".

Punta Alta was a low cliff about twenty feet high, of alternating layers of gravel and a reddish, muddy clay, with seashells scattered through them of the same kinds found along the beach. The gravel was a perfect graveyard, and Darwin, already on the lookout for fossil bones, during the one day he had to spend, found enough ancient relics to start a museum. This is the list: a nearly perfect head of the extinct giant sloth, another member of the same more or less toothless order with great scatching claws and as large as a pony, two more edentates related to the giant sloth, fully as large as an ox, a toxodont, which was something like a guinea-pig built on the scale of a prize-winning bull, a large piece of skin armour of an armadillo but of gigantic size, a tusk like that of a boar, and lastly a tooth that he thought was identical with that of the common horse. Horses had been introduced into South America by the Spaniards, but this tooth was embedded in the gravel with the other bones and was in the same state of decay.

It is an imposing and startling list and it is no wonder Darwin stayed awake at night thinking about it. For it was evident that a now extinct fauna of large quadrupeds lived in this region not so long ago, geologically speaking. The bones were not even true fossils, for they were not mineralized, but were just bones undergoing decay, though they belonged to animals of kinds no longer existing. That a new fauna had replaced an old one was in itself not surprising, for there was already a theory of successions of faunas in relation to a series of cataclysms. Strange extinct remains were to be expected, but what is new is Darwin's recognition not only of the relatively giant size of the extinct forms but their general relation to existing animals, and his speculations concerning what could have brought about the change. This was the first impact of the past; others were to come.

In the meantime Darwin continued his journey to Buenos Aires and saw much of the ostrich, a bird shy, wary, and solitary. "And although so fleet in its pace, it falls a prey to the Indian or Gaucho armed with the bolas. They generally prefer running against the wind, yet at the first start they expand their wings, and like a vessel make all sail." Which sounds, I think, not so much like sailing before the wind as a bird going through the motions of taking to the air. Any ostrich is a queer-looking bird, but perhaps the breeding habits are even more curious—"when we were at Bahia Blanca, in the months of September and October, the eggs, in extraordinary numbers, were found all over the country—either scattered single, in which case they are never hatched—or they are collected together into a shallow excavation which forms the nest. The Gauchos unanimously affirm that the male bird alone hatches the eggs, and for sometime afterwards accompanies the young. The cock when on the nest lies very close; I have myself almost ridden over one. . . . I observe in Burchell's travels in South Africa that he remarks 'having killed a male ostrich, and the feathers being dirty, it was said by the Hottentots to be a male bird'. I understand that the male emu, of Australia, takes charge of the nest: this habit, therefore, is common to the family. The Gauchos unanimously affirm that several females lay in one nest. I may add, also, that it is believed in Africa that two females lay in one nest. Although this habit at first appears very strange, I think the cause may be explained in a simple manner. The number of eggs in the nest varies from twenty to forty, and even to fifty." Darwin goes on to explain that, since one large egg is laid every third or fourth day, a single female could not complete the laying of its clutch before the first-laid eggs were addled, and that only a co-operative system whereby all females in a neighbourhood who have an egg to lay, lay it in the same nest, so that any one nest has eggs that were laid more or less at one time. The odd eggs scattered about the landscape he thought arose from the difficulty of several females associating together and persuading an old cock to undertake the office of incubator. They had to start laying whether he was ready or not.

Darwin was only partly correct in his assumptions, and the true account of these goings-on comes from W. H. Hudson, who was born and raised in this purple land. All the females of a flock do lay in a single nest, but the number of eggs laid by each hen is about a dozen and they all go into one nest, not into a number of them, as Darwin thought. When there are several females in a flock the temperamental cock may get tired of waiting to start his maternal duties and drives away the laggards, so that those left with some eggs yet to lay drop them here and there on the bare floor of the pampas. Once set, the cock sits almost continuously for seven weeks. After all, it gains the right to sit down only as the result of strenuous effort. For old cocks have to drive the younger ones away, and if two old ones are left they have to fight it out, pounding round and round in a circle with viciously biting beaks at the end of long and twisting necks. Then the winner sends out his deep, booming mating call.

The South African bird really pre-empts the name of ostrich, and the South Americans walk by the name of rhea by virtue of having three toes in place of two. After all, there is something in a name, as any Texan knows, even without the distinction of an extra toe.

Actually there are three rheas in South America: the common one, *Rhea americana*; a second high in the Andes, and a third *Rhea Darwinii*, which is only found in Patagonia to the south of Rio Negro. It was named in honour of Darwin but only by the grace of God, for the specimen he brought back with him had officially been already cooked and eaten before he remembered having heard of a new kind of ostrich and that what he was eating conformed to its description. Fortunately, the head, neck, legs, wings, and much of the skin and feathers remained and they eventually were reassembled in a London museum almost as good as new.

The ride to Buenos Aires was enlivened also by armadillos. It was not only that they were common and peculiar, but they were of several kinds, each one in its own way an unbelievable sort of animal—the picky, peludo, apar, and mulita. Peluda alone was nocturnal, the others wandered by day over the plains, feeding on beetles, grubs, roots, and even small snakes. Apar had only three movable bands of skin armour, but could roll itself up into a ball, which the others could not. And picky, the little one, preferred dry soil and the coastal sand dunes and got along for months without water—"the instant one was perceived, it was necessary in order to catch it almost to tumble off one's horse, for the animal burrowed so quickly its hind quarters disappeared before one could alight. It appears almost a pity to kill such nice little animals, for as a Caucho said, while sharpening his knife on the back of one, 'they are so quiet'." And to cap it all there was a little toad that looked as though "it had been steeped in the blackest ink, and then when dry, allowed to crawl over a board freshly painted with the brightest vermilion so as to colour the soles of its feet and parts of its stomach,—a fit toad to preach in the ear of Eve!"

Food on the way presented no difficulty, for always there were eggs—one ostrich nest yielded twenty-seven eggs, which Darwin calculated, on the basis of one to eleven, was equivalent in food value to two hundred and ninety-seven hen's eggs. There were also many plovers, since it was southern spring and the golden plover was already present in large flocks that had winged their way from the approaching winter of the arctic tundra. Partridges, so called, abounded, which gave good meat and were easily caught. "It appears a very silly bird"—and a boy on a quiet old horse, with a running noose made of the stem of an ostrich feather fastened to the end of a long stick, could catch thirty or forty in a day. They were about the size of hen pheasants, but were a curious kind of land bird better known as the tinamous, not unlike the common fowl, though able to fly. But not even Darwin was ready to think of tinamous and ostriches as having anything unusual in common—that would come later.

Beyond Buenos Aires the journey continued for about two hundred miles up the Paranama River to Santa Fe, through occasional cattle-ranches separated by extensive purple tracts of acrid clover and the great, impenetrable thistles, inhabited only by a long-tailed burrowing rodent and its friend the little owl. The river-bank of course meant another opportunity for searching for fossil bones, for year by year the freshets sliced away new layers of the steep banks, leaving skeleton after crumbling skeleton exposed. Bones there were, and plenty of them, though the greater number were rotten and as soft as clay, especially those of the mastodon, the kin of elephant and mammoth.

The men who took Darwin by canoe to the cliffs of the mastodon bones said they had long known of them and had often wondered how they got there—"the necessity of a theory being felt they came to the conclusion that the mastodon formerly was a burrowing animal!" He found there also more casing of the giant armadillo and another tooth which this time was unmistakably that of a horse. At another point he found his second toxodont and more armadillo armour, which differed, however, from what he already possessed. More than one gigantic animal of a former age was protected by a coat of mail! Darwin already knew of discoveries of fossil elephants and mastodons in Europe and Asia, and even at his early age, so long ago, suspected that his mastodons had walked across a Siberian–Alaskan bridge that had since disappeared.

At last, after he had rejoined his ship at Buenos Aires in early December, "the *Beagle* sailed from the Rio Plata, never again to enter its muddy stream. Our course was directed to Port Desire on the coast of Patagonia." On the way, ten miles or more offshore, the seamen cried out that it was snowing butterflies, myriads of them extending in all directions as far as the eye could see, flocks as large as Columbus saw to the south of Cuba.

Butterfly migrations such as these are a little better known than they used to be, although what determines their course is as obscure as ever. As a rule the flocks consist of males alone and they fly to their death. As much as anything it seems to be a way of removing an excess of comparatively useless individuals from overcrowded areas, for biologically speaking the sexes are not equal, and the run of males for the most part are dispensable.

At another time, sixty miles at sea, vast numbers of small spiders, of all ages, drifted by in the air, each hanging on to the end of a long thread that served as a kite.

The *Beagle*, it must be remembered, was a naval ship on an extensive surveying expedition, and the captain's concern lay with coastlines and harbours. Darwin, as a naturalist, just went along and made the best of his opportunities, although it was at Captain Fitzroy's request that a naturalist accompanied him. Only brief trips ashore could be made at places that were not to be revisited by the ship, and little more than glimpses were possible of the southern Patagonian river-courses. One was of the Port Desire River, on Christmas Eve of 1838, and the other the river Santa Cruz the following spring, three hundred miles from the Strait of Magellan.

From the barrens of the Rio Negro, Darwin had ridden north into the green-and-purple plains of the cattle ranches. The present landings were four and five hundred miles south of the Negro and, while he thought he had seen desert land before, it was nothing to this. The vast plain was all gravel, with not a drop of water and but little vegetation, and even more remarkable, the surface was covered with the blue and purple shells of marine mussels and clams. It was clear as it could be that the plain had lain beneath the sea, and not so long ago at that. Only the guanaco—llamas—being camels, could make a living in such a place. Darwin saw herds of five hundred along the banks of the Santa Cruz, and many more on both shores of the Magellan Strait. To give a picture of one he compares it to "an ass, mounted on taller legs, and with a very long neck". They appeared to have favourite spots for dying in, and on the banks of the Santa Cruz the ground was actually white with bones. In one place he counted between ten and twenty heads. I think the sight of them would have stopped any man.

Yet for all its desolation southern Patagonia set the stage for what was to follow in the equatorial Pacific; it turned a brooding mind to look backwards into time. The bones of Punta Alta and the Paraná gave direction, the llamas and the shingle deserts gave motion. In Darwin's own words, "Five successive plains of different altitudes are very distinct. The lower one is a mere shingle nearly on a level with the sea, but the upper one is elevated 950 feet—the entire plains extending seven hundred miles in length, and backed on the one hand by the chain of the Andes and fronted on the other by the shores of the Atlantic. . . . The level plains are cut off along the whole line of coast by perpendicular cliffs, necessarily of different altitudes because any one of the successive terraces may form the sea cliff. . . . Having observed that the plains appeared to run for greater distances along the coast at the same level—I was astonished to find at how great distances, even of 600 miles, plains occurred that had the same elevation. . . . I have called these step-like plains level, but in truth they rise between the edge of one line of cliff and the base of the next above it. Their slope is about the same as that of the gradually shoaling bottom of the neighbouring sea. Over these plains marine remains are frequently scattered, but they are especially abundant on the lower one. The shells are the same as the now existing littoral species, and the mussel and turbo yet partially retain their blue and purple colours."

He visualizes a sea breaking along the eastern foot of the Andes, the shoaling bed of the ocean slowly and steadily rising and becoming dry land, and then a pause. During the pause a cliff forms along the sea edge. The slow uplift recommences and again stops. A second sea cliff forms at the shore line, and the process of rise and pause goes on until seven or eight terraces are left high and dry between the mountains and the sea. The planet not only spins on its axis and circles the sun, but the earth has developed a pulse, the land begins to rise and fall. The past is alive, the land as well as its creatures, and you can feel a young man's mind moving along its path.

So much for the high beaches. But in a dirt-filled hollow on the lowest level Darwin found embedded a group of large bones. The dirt and the bones lay above the surface layer of shells, and must have lived at a time much more recent than the raising of the last beach, when, he thought, the climate could not have been very different from what it is now. And the questions arose in his mind. "How could any large quadruped have subsisted on these wretched deserts?" and what kind of animal was it? The first question is left unanswered, but the animal itself turned out to be a guanaco, or llama, as big as the true camel. He follows with this—"the most important result of this discovery is the confirmation of the law that existing animals have a close relation in form with extinct species"—guanacos with giant llamas, sloths and armadillos with giant sloths and giant armadillos.

Past life has given place to present life, which is different in small ways but similar in kind. The concept of continuity combined with change begins to form, and only the ingredients of island life have yet to come. In the dawning of new ideas the mind is a groping thing, and in reading the *Beagle* journal you feel the wonder, the doubt and hesitation, and the slowly mounting certainties that led Darwin along the path to the evolving universe.

20

ISLANDS OF EVOLUTION

Islands are worlds unto themselves, and each has its own degree of enchantment and desolation. The *Beagle* left Patagonia for the last time and sailed east to the brown and dreary wind- and rain-swept Falklands. They appeared to be no place for man or beast, yet the islands were a sanctuary for murderers and flightless birds. Now sheep take the place of outlaws, but some of the birds remain.

The birds were important, for they made it clear to Darwin how flight could become transformed into other forms of locomotion. His own descriptions are brief and vivid: "One day, having placed myself between a penguin and the water, I was much amused by watching its habits. It was a brave bird, and till reaching the sea, it regularly fought and drove me backwards. . . . This bird is commonly called the jackass penguin, from its habit, while on shore, of throwing its head backwards and making a loud strange noise, very like the braying of that animal; but while at sea and undisturbed its note is very deep and solemn and is often heard in the night. In diving, its little plumeless wings are used as fins, but on the land as front legs. When crawling (it may be said on four legs) through the tussocks or on the side of a grassy cliff, it moves so quickly that it might be readily mistaken for a quadruped. When at sea and fishing it comes to the surface, for the purpose of breathing, with such a spring, and dives again so instantaneously that I defy anyone at first sight to be sure that it is not a fish leaping for sport."

There were geese as well as penguins, an upland species that fed on grass and other vegetation and built its nest on the small outlying islets, and the snow-white gander and its darker mate, rock geese that found a living on the beaches. But the one that caught a young man's fancy was the steamer duck, a goose weighing more than twenty pounds. All South Atlantic voyagers between the islands and the Horn have watched it with amazement. The older name was the race horse and it only became the steamer duck as the first of the side-wheeling paddle steamers edged its way into sail while Darwin was a boy. As for the birds themselves. "their wings are too small and weak to allow of flight, but by their aid, partly swimming and partly flapping the surface of the water, they move very quickly. The manner is something like that by which the common duck escapes when pursued by a dog, but I am nearly sure that the steamer moves its wings alternately instead of both together as in other birds. The steamer is able to dive only a very short distance. It feeds entirely on shell-fish from the kelp and tidal rocks, hence the beak and head, for the purpose of breaking them, are surprisingly heavy and strong. Thus we find in South America three birds which use their wings for other purposes besides flight: the penguin as fins, the steamer as paddles, and the ostrich as sails to a vessel."

With the Falkland Islands left behind, the ship sailed once more to the west and beat against the wind to the Strait of Magellan, to pass through the strait during the southern midwinter. Only the giant kelp of the narrow seas took Darwin's attention from the bleak and glacial landscapes—"great brown blades growing from inch thick stems a hundred and more feet below the surface. Almost every leaf is so thickly incrusted with corallines as to be of a white colour. We find exquisitely delicate structures, some inhabited by simple hydra-like polyps, others by more organized kinds, and beautiful compound ascidians. On the flat surface various limpets, whelks, sea-slugs and some bivalves are attached. Innumerable crustacea frequent every part of the plant. On shaking the great entangled roots, a pile of small fish, shells, cuttle-fish, crabs of all orders, sea eggs, starfish, beautiful holothurians, planarians and crawling worms of a multitude of forms, all fall out together. . . . I can only compare these great aquatic forests of the southern hemisphere with the terrestrial ones in the inter-tropical regions.—Amidst the leaves of this plant numerous species of fish live which no where else would find food or shelter; with their destruction the many cormorants, divers, and other fishing birds, the otters, seals, and porpoises would soon perish also; and lastly the Fuegian Savage, the miserable lord of this miserable land, would redouble his canibal feast, decrease in numbers and perhaps cease to exist."

Here is the web of life in all its rich complexity, with a seaweed as its base and everything struggling for a place on or among the blades. It brought to his mind the sea-slugs of the Falklands—a single spawn of a sea-slug contained more than six thousand eggs—yet in spite of intensive searching he found no more than seven grown slugs. The struggle for life was beginning to loom large.

In June, 1834, the *Beagle* passed into the Pacific between the East and West Furies, through a sea with so many breakers that it was called the Milky Way. "One sight of such a coast is enough to make a landsman dream for a week about shipwreck, peril, and death!" Add perpetual sea-sickness and you get misery personified.

For more than a year the ship worked its observing way up the Pacific coast, and like Humboldt before him, Darwin found more to do as geologist than naturalist. There were visits to Valparaiso and Lima and the country around, but the more interesting wild life was human. At Valparaiso there was a German collector who in many ways was a kindred soul, and who had this story to tell: Two or three years before, he left some caterpillars in a house at San Fernando, under charge of a girl, to turn into butterflies, and this was so talked about in the town that the priests and the governor conferred together, agreed it must be some form of heresy, and arrested him on his return. Farther up the coast at Coquimbo he heard another tale, of a school that had been closed to give the boys a holiday when the captain of an English ship came from the port to the city—like a visiting Martian, for nothing would have induced anybody in the school to have gone close to the Englishman, so greatly were they impressed with the dangers of heresy, evil, and contamination such a being carried with him. One old lady remembered taking to the mountains as a girl, with all her valuables, whenever the cry of "Los Ingleses" was raised, for it could only mean the buccaneers had landed.

The last call before swinging out along the equator to the Galapagos Islands was at Lima, and for once Darwin shows his actual age, for what impressed him most, as better worth looking at than all the churches and buildings of the town, were the ladies, fitted in close elastic gowns, with a black silk veil brought over the head allowing only one black and brilliant and powerfully expressive eye free to appraise the young foreigner. He felt, he says, as much surprised as if he had been introduced among a number of nice round mermaids!

September 15, 1835: "The *Beagle* arrived at the southernmost of the Galapagos Islands, of which five much exceed the others in size. They are situated under the equatorial line, and between five and six hundred miles to the westward of the coast of America. The constitution of the whole is volcanic. . . . I have no exact data—but I do not hesitate to affirm that there must be at least two thousand craters.—The natural history is very remarkable: it seems to be a little world within itself, the greater number of its inhabitants, both vegetable and animal, being found nowhere else."

There you have it! Two problems in a nutshell, even though slightly petrified! How did animals and plants ever reach the islands, and why are they so distinctive?

Darwin's first walk, on a glowing hot day among the little craters, brought him face to face with two large tortoises, each one a 200-pounder, busy eating cactus. They looked at him and hissed, and slowly walked away. Among the leafless shrubs, the tall cacti, and the black, forbidding lava they seemed not out of place but out of time.

Along the shores the rocks abounded with great black lizards between three and four feet long, and on the hills another kind was just as common. There were smaller lizards too, and several kinds of snakes, but no frogs or toads. And there was a large mouse with large thin ears, like a kind he knew from the sterile deserts west of the Andes. Birds, especially turtle-doves, were tame, but not so tame as they used to be. "Dampier says that a man in a morning's walk might kill six or seven dozen of these birds. . . . At present they do not suffer themselves to be killed in such numbers." Dampier left his mark, for all these later travellers knew him well.

The three great reptiles hold the stage, and Darwin's accounts of them are more detailed and accurate than his buccaneering predecessors', and fresher than those left by later visitors. The tortoises, that Dampier reckoned could support an army of men for several months, lived on juicy cactus on those islands which were without water or where the land was low and arid, but in higher, damper regions where trees grew, ate leaves and berries and hanging lichens. On the larger islands, where there were springs high up toward the central parts, the thirsty, mud-loving, perambulating tanks made well-beaten paths in every direction from the wells even down the sea-coast, and Spaniards by following them up first discovered the watering-places. It was curious to see one set of the monsters trudging eagerly uphill with outstretched, thirsting necks, and another set stumbling down and almost spilling over. Darwin found that they could speed along at a brisk six yards a minute.

Land-tortoises, fresh-water terrapins, and sea-turtles all dig a pit in which they lay and bury their eggs, but not these. You dig no holes in a lava-flow, and except where there was sand and the old instincts could work their way, eggs were dropped in any hollow or crevice that would hold them. And but for rats it wouldn't matter.

The two big lizards drove home the lesson of the birds and their wings, "a variation in habit accompanying change in structure". When Darwin found it, the aquatic lizard was extremely common on all the islands of the archipelago, living exclusively on the rocky sea beaches and never even ten yards inshore. Black imps of darkness, they swam with perfect ease and speed by a sinuous movement of the body and flattened tail, feeding on submerged seaweed. Even a forced submersion of over an hour did not drown one. "Their limbs and strong claws are admirably adapted for crawling over the rugged and fissured masses of lava, which extends inland everywhere from the coast. In such situations a group of six or seven of these hideous reptiles may often times be seen on the black rocks, a few feet above the surf, basking in the sun with outstretched legs." He could not discover where they laid their eggs.

The land-lizards were confined to the central islands: "it would appear as if this species had been created in the centre of the archipelago, and thence had been dispersed only to a certain distance." This is creationist language, and the fact that Darwin does not seem concerned with how the lizards came to be on the islands suggests that he is using it literally; but biological thought generally was in transition between creation and some sort of evolution, and the meanings of words were slowly shifting.

Like their brothers of the sea, the land-lizards were ugly, and apart from having a rounded tail were of much the same shape. But the back was brownish red and the belly a yellowish orange. "I cannot give a more forcible proof of their numbers than by stating that at James Island we could not for some time find a spot free from their burrows on which to pitch our tent." The burrows were made as a rule on level patches of soft volcanic sandstone. When not frightened the animals slowly crawled along with tails and bellies dragging on the ground, and even when scared they rushed to their burrows with a most awkward gait, without care for the eggs they may have laid within. Neither the land- nor the sea-lizard has the rapid movement so characteristic of the true lizard and the iguanas of the mainland.

In his collections of birds Darwin found twenty-six different species of land-birds, all but one unique to the archipelago. The most significant were a group of thirteen species of finches, still known as Darwin's finches, and three species of mocking-birds. What makes them so important is the manner of their distribution among the various Galapagos islands, and the fact that he brought this information into association with what he had been told about the tortoise. At the time of the *Beagle's* visit there was a colony of political prisoners from Ecuador stationed on Chatham, one of the larger islands, in charge of an Englishman named Lawson, and "it was confidently asserted that the tortoises coming from different islands in the archipelago were slightly different in form; and that in certain islands they attained a larger average size than in others. Mr. Lawson maintained that he could at once tell from which island any one was brought."

The mocking-birds and the ground-finches told the same story, only even more clearly. One species of mocking-bird lived only on Charles Island, another on Albemarle, and the third only on James and Chatham. The ground-finches varied all the way from thick-beaked kinds to some with beaks as fine as a warbler's, with other differences as well, and they, too, were distributed one kind to one island. With these things in mind it became time for him to go, for "it is the fate of every voyager, when he has just discovered what object—in any place is more particularly worthy of his attention, to be hurried from it". And the *Beagle* departed with Darwin aboard once more, for Tahiti, and the long voyage west around the world. There is no speculation in the journal concerning the meaning of the variations of the Galapagos birds and reptiles, no putting together of this information with the struggle for a place among the seaweed forest or the tremendous output of sea-slug eggs needed to maintain a sparse adult population, no bringing of the extinct South American giants and the rising land into the picture with the rest. He went on to see the rest of the world and to wonder about the nature and origin of coral reefs, to arrive at last in England in October, 1836. Yet questions bothered him: Why should species have been created slightly but distinctly different on each island? Could they have all come from a single stock and become different in the course of generations?

Less than a year after his return, in July of 1837, he started the first of his note-books on the *Transmutation of Species*, and in a little diary of the same date noted that he had been greatly struck with the character of the South American fossils and the species on the Galapagos Archipelago, and that these facts were the origin of all his views. Many years later the note-books reached their maturity as *The Origin of Species*.

Other men had played with the idea of evolution, but no one had proved that it really happened. Darwin returned from the voyage of the *Beagle* with his mind buzzing with new thoughts, which alone might or might not have been enough; but he returned to the life of a country gentleman in a farming community where the selective breeding of sheep and cattle was already a fine art. And he was able to see the obvious, that if selection among the offspring of domestic animals could produce new strains, the same sort of process might do the same in nature. Finally it came together, and after twenty years of hard labour he showed to enthusiast and sceptic alike that animals vary and that some variation is heritable, that animals breed excessively but their numbers are forever being cut down by adverse circumstances—and that the inevitable result of all this is that the varieties best suited to meet their circumstances will survive at the expense of others—and that this leads to the gradual evolution of new kinds in response to changing surroundings. It is the beginning of our own journey into wonder, believing in the continuity of all life in spite of its diversity. St. Francis felt it long ago, and now we begin to see it.

The Galapagos cormorant has wings but cannot fly. There is little reason why it should. There is no danger on land and no difficulty in landing directly on the ledges from the sea. And apart from aerial flight, a cormorant's wings only get in the way of its swimming. They are not used underwater, yet are forever having to be dried out, for the plumage wets too easily. With no other island groups on nearby coastline to encourage migrations, these Galapagos birds are complacent stay-at-homes, content with their islands and always able to get a good meal from the nearby sea. For the sea is green and full of fish, with little of the empty blueness of tropical waters. Birds with no need of flight can stray from the straight and narrow path that flight demands, and suffer no harm when wings get small. To cormorants on Galapagos it hasn't mattered whether they flew or not. Or perhaps we read the story backwards, that full-winged cormorants flew away but this little short-wing stayed at home—it had to.

Yet it happens every time. Every island of any size that the modern mammals failed to reach has sported flightless birds. Pigeons of a sort reached Mauritius in the tropical Indian Ocean, grew large and dumpy and forgot to fly. It was an island paradise till Dutch sailors landed in Elizabethan times, and the dodo was discovered. They found another of the dodos on Rodriguez, three hundred miles to the east. But mariners of the seventeenth and eighteenth centuries spread hogs and goats as well as the rats, which ate the dodo eggs. When Dampier passed that way, it was all over, the dodos were gone for good. Another giant tortoise flourished with the dodos, like the one on the Galapagos, but passing ships took most of them and only a few are left.

Dodos, flightless cormorants, and the flightless rails found in New Zealand are recognizable birds; they can be placed in their proper families with their relatives, and there is little doubt what has happened in the safety and laziness of South Sea islands. But there is another group that cannot fly, have some queer things in common, and have raised a hot argument among zoologists. The list is short, yet it carries a lot of weight.

Madagascar, the largest island, held the largest bird—a timid bird, the legends say, though it is too late to make sure of this or of much else we'd like to know. It goes by the name of elephant bird or Aepyornis, given by those who knew it only by bony remains and empty shells. The Arabs, who may have done much to exterminate it, called it the roc, the giant bird of *The Arabian Nights*. Marco Polo brought back the story. Enough of the bones have now turned up to give a good idea of what it was, and the picture you get fits the eggs it laid, a shell holding two gallons of yolk and white of egg, the largest ever made. It makes the ostrich egg look small, for it was thirteen inches long by nine and a half wide.

There were actually more than a dozen species of rocs on Madagascar, but the largest was not merely as tall as an ostrich, it was nearly all body—it walked on short, stumpy legs, with thigh-bones only a foot long, yet half a foot thick, and looked much like a goose, though ten feet high and maybe higher. Sheer bulk protected it and its turkey-sized chicks from the comparatively harmless mammals of the island, there was no need for the speed and long legs of an ostrich. Man arrived, first the early Polynesians, then the Arabs, and it was soon over. Only when natives came from the island to Mauritius to buy rum, and brought with them two eggshells as containers, did European anatomists take Marco Polo seriously enough to go and make a search. They found eggshells and bones in abundance, but the bird was gone forever.

There had been other birds as tall, though not so bulky. The moas of New Zealand—some of them, at least—were alive when the Maoris first arrived, for, quite apart from legends, the skeletons of Maoris and the large eggs of moas have been found buried side by side. There is little doubt the Maoris hunted them and brought the last extinction, for they took both eggs and birds. There were moas in shape and size like some of the larger rocs, others were longer legged and longer necked, more like an ostrich, but twice as big, and some were small according to their standards. None of them had wings.

The kiwis survive. Moas were their nearest relatives, perhaps. Kiwis, being dark and smaller, and only coming out at night, have stood a better chance since the human occupation. They have a trace of a wing in the form of a few bones beneath the body plumage, which is more than you can find in a moa. No larger than the common fowl, they come out to feed at dusk, probing with long rapier beaks for worms and grubs in the moist soil. They can run like the wind, and have the custom of their kind of kicking forward violently at any offending creature. And like their kind again, they lay magnificent eggs, relative to their own size the largest of them all.

Farther to the west, in northern Australia and the islands of New Guinea, New Britain, and other parts of Melanesia, the cassowaries, like ostriches with shorter neck and legs, walk their equally wingless way through the forests. On the great Australian plains, where there is space to run, their place is taken by the emu with its longer legs.

This is the group, together with the rhea and the African and Arabian ostriches. All have powerful thighs and legs that develop great speed or carry great weight. All lay very large eggs. Wings are either small and ornamental or are missing altogether In none is there a keel to the breastbone nor any large breast muscles—the chest is flat. And last but far from least, all have a peculiarly primitive palate in the skull, found in only one other living bird.

What are we to make of them? One thought which is dying hard is that these are birds that have never known flight, that certain groups of reptiles now long extinct, which ran powerfully on their hind legs alone and waved short arms as they ran, evolved feathers and wings as the ages passed—that some of these went on and took to the air, but others remained running on the ground, and left us these, their descendants. It might have happened like this, but I don't believe it did.

There is another theory and another starting point that makes less demand upon credulity, which is this: that these large-legged, flat-chested birds have evolved from birds that could fly, and that of all living birds the tinamous that Darwin saw come nearest to the ancestral type. They range from Mexico to southern Patagonia, and they have all that we need. For tinamous, alone of all other birds, have the same primitive palate, and the importance of the palate is that it is a feature which cannot possibly be connected with the structures of flight and running, has nothing to do with habits or activities, and indicates true blood relationship.

If the tinamous are closely related to the great running birds, then we are, I think, well away; for tinamous can fly, though none too well, and they can run a good deal better. Here is the point. No bird can grow large and heavy and continue to fly. The limits are known, and beyond a certain size, wing-spread and chest-muscles become impossibly great. The balance is delicate, and for the size of its wings the tinamous are about as heavy as a bird can be and still get off the ground. A little larger wing and lighter body and it could take to the clouds. Equally well a little extra weight and flight would be quickly a thing of the past. Which is most likely what happened among some of their kind a long time ago. Birds such as these were once widespread across the earth, and wherever it has been safe to do it they have gone in for large dimensions, large legs, and a pedestrian life. Wings no longer of any use degenerated in the course of time, in part or all the way.

So much for the type, but there is more to the story than this, and in the end it takes us back to the reptiles, after all. Modern reptiles are mere remnants of the time when reptiles were the lords of the earth. Toward the end of that epoch the birds came into being, and there was a period, long in years but otherwise short, almost a pause, between the departure of the great reptiles and the appearance of the mammals in force when the stage was empty. An empty stage calls for an actor, and for just a little while the birds took over on the ground as well as in the air. They had their brief moment when they, too, stalked across the land like a fantastic echo of the reptilian past. Then the mammals came, and their time was over. Only the ostrich stood its ground, by keeping to the wide and open spaces and running at sixty miles an hour.

At the last we come back to the islands, of one kind or another. Madagascar, Australia, Melanesia, and New Zealand are all asylums never invaded by more than the first wave of pouched mammals, at least until men and their dogs entered the picture. And in all of these the great grounded birds have lived on into our own recent time.

Some problems remain. To what extent have the larger birds evolved from smaller kinds, maybe even from tinamous, on each of the islands independently—to what extent, and how have they managed to spread from one place to another? Cassowaries, for instance, are good swimmers, and the Melanesian Islands and Australia are all fairly close together. To what extent perhaps has an extensive land disappeared, leaving behind islands, each loaded with a living freight? The trouble lies with New Zealand, so far off by itself. Did birds fly there and then lose their wings, or were there land or island stepping-stones to walk across? We can only speculate and wonder.

21

CURRENTS OF LIFE

TEN YEARS before the *Beagle* called at the Galapagos, Narborough, the westernmost of the islands, a volcanic tip rising four thousand feet out of the sea, blew up and deposited a wide mass of boulders and black lava all around its base. Land life and even the soil was destroyed, except for one small region. Darwin had no time to visit this island, and had no particular reason to think that he should. Had he done so he might have had a better chance to spot two other inmates of the Galapagos asylum, the little penguin and the flightless cormorant. Other creatures would have been there, basking on the smooth glassy rocks, not only the black sea-lizards, but fur seals and antarctic sea-lions, all of them living in amiable and uncompetitive propinquity.

I know of no better substitute for counting sheep on a sleepless night than thinking of the questions raised by the Galapagos and trying to dream up the answers. Where have the animals and plants come from, how did they get there, how have they managed to live there after they arrived, and what has happened to them since their arrival? Almost every problem of evolution and world history finds its place in this cluster of small equatorial islands.

There is the tortoise. It is bigger than most, but that is the least of it. A tortoise is a tortoise, and we take it for granted, but as reptiles go it is thoroughly antique, and there were tortoises of a kind, with something like their present peculiar armour, stumping around in the warm, dry and deserty part of the earth before there were dinosaurs, before the great age of reptiles was ever under way. Within certain latitudes it is world wide, and true tortoises have been ready to make the best of a landing on the Galapagos for nearly one hundred million years. Whether the Galapagos were there to land upon is another matter.

One thing is certain: no tortoise ever swam the distance from Peru to the Galapagos, or even drifted with the current without some sort of help. Many persons have worried over how the tortoise made the trip, and some insist that it walked on dry land and, like the ploughman, plodded its weary way every step of the journey. The travelling tortoise is explained by making a land bridge from Central or South America to the Galapagos. A submarine plateau is already there, but to make it emerge above the surface means raising it by another ten thousand feet, and it is a case of out of the frying-pan into the fire, for the absent bridge is more disturbing than the present tortoise. At least, I find it so.

A land bridge implies that the islands have been a part of the continent and as such they should show the continental structure in the rocks. They do not, and few islands anywhere flaunt their volcanic origin and character as blatantly as these crater-ridden tops of mountains rising from the floor of the deep sea. Even if we agree to the land bridge, forgetting the geological difficulty, the bridge merely changes the nature of the problem. It makes a road for a tortoise but it also makes a road for a toad, and neither frogs nor toads nor salamanders, nor the host of creeping and crawling things of the tropical mainland that would have had ample time to travel the few hundred miles ever reached the islands. There was no bridge, and the tortoise is back where it started.

If not by land then by sea, for a tortoise has yet to learn to fly. What are the chances of drifting undrowned on a tree trunk to the Galapagos? Depending on where you start they may be not at all bad, especially if you happen to be as tough as a tortoise—few animals put up with so much and need so little. Two currents reach for the Galapagos from the American coast, the cold Peruvian, or Humboldt, Current, from the south-east during the three-quarters of the year that the south-east trades blow, and a warm current from the general direction of Central America during the time of the north-east trade winds of the northern winter.

Between them the two currents account for much that is peculiar to the archipelago. For the anomaly of the islands is that the land supports a tropical continental American fauna and flora, while in the surrounding equatorial sea the life has an antarctic likeness. There is no coral in the waters round these islands.

One of the most striking passages in William Beebe's *Arcturus Adventure* describes a rip marking the line separating two currents running side by side in these seas, where the water was thick with floating land debris of all kinds, from seeds and grasses to the trunks of fair-sized trees. Torrents pouring down from the tropical forests of the Isthmus carry flotsam and sediment into the sea and out with the warm current toward the Galapagos, and the ocean floor is covered with decaying vegetable matter far out along the line of drift. And the eastern shore of Chatham Island, the first island to be encountered from the east, has driftwood of a larger size than any of the trees growing locally, not to mention bamboos, sugar-cane, and coconut, none of which grow in the archipelago. Here is the road that the reptiles travelled, clinging to the trees and rafts of jungle-growth that drifted to the islands. It would take but two or three weeks, and in the course of many million years the wonder is so few have found the way. A single tortoise, lizard, or snake with eggs about to be laid would do the trick, and so would a pregnant mouse or rat. Frogs may have started the journeys as often as lizards, but a touch of the sea and a frog is soon dead; its naked skin needs moisture pure and unsalted.

The great lizards as well as the little up-to-date fellows must have taken the same journey, although neither they nor the tortoise may have been as big as they now are, when they first emigrated. There has been plenty of time for change since they made their landing. The question is, did one kind of these lizards, or two, make the initial voyage? The trouble is that none of their kind is alive anywhere else, and I doubt whether you, or anyone, could tell the difference between the two of them as fossils. None has been found. But either before departure or after the landing—the sea-lizard probably evolved from the land-lizard—it doesn't work the other way round.

The closest relatives of the big Galapagos land-lizards are the iguanas of tropical America, although they are much more alert and lively creatures that lift their bodies clear of the ground when they start moving. They have to, or be eaten by warm-blooded and quicker mammals. The Galapagos kind never gets its weight fully on to its feet, and cannot put on anything like the same burst of speed. In this they are old-fashioned, as reptiles go, but there are two ways of looking at it. The mainland crowd, that stayed behind, were also heavy and weak-legged at one time, but have since had to get moving to stay alive, or else the island group, free in an isolated sanctuary without need to move except to eat or breed, has grown weak in the legs and heavy. The position of the legs, however, well out to the sides of the body, favours the first and labels the islanders as archaic.

However it was, the black sea-lizard and the brown land-lizard are more closely kin than either of them is to any other, and it is likely that at some place and time either the land form took to the sea or the sea beast took to the land and gave rise to the other. Supposing some of the land-lizards took to the sea to add seaweed to what may well have been a scanty diet on shore, those with the most blade-like tail would swim better, avoid more sharks, and live longer. Their eggs would be the ones to produce the next generation. And from generation to generation flatter tails and better swimmers would survive the longest and lay the most eggs. Gradually the sea-lizard would come into being, with a flat, swimming tail in place of the thick, clumsy one its ancestors had dragged around. This way it works, from land to sea.

Suppose we try the other way, from sea to land. A sea-lizard could take to the land again without much difficulty, as long as its legs remained strong enough, but there would be no necessity, incentive, or reason for its blade of a tail to revert to the heavy, roundish tail of a land-lizard. No premium would be placed upon rounder tails, and their bearers would not live any longer than the rest, would not lay more eggs or produce more of each succeeding generation. This way it doesn't work, and the land-lizard seems to me to be the conservative stay-at-home, a land-lubber whose one ocean-crossing was enough of the sea for all time. Yet on the Galapagos even the land-lizard has had to change in some degree, and while selection has left the tail alone, those that finally flourished have jaws and teeth so strong they can literally chew shoe-leather. It speaks something of the general toughness of the plants that also drifted and settled on the black volcanic islands.

Islands have had a small part to play in the grand sweep of evolution as a whole, but they have played a large part in the progress of our understanding of it. All in all, their value to the animals and plants that find themselves surrounded by the sea is of two kinds. First and foremost, islands are sanctuaries. The lizards and tortoises of the Galapagos arrived there to find no enemies of any kind. They were free to live in happy isolation just so they didn't eat themselves out of house and home. They went about their own business undisturbed until buccaneers and whalers raided them for food, and various transient settlers brought in cattle, horses, and goats, and dogs and cats, all of which in one or two generations have gone back to their original wild and undomesticated state. There are no islands any more, and as men in ships make moving bridges between continents and islands, all that made them sanctuaries disappears, and the archaic living fossils go down before the more aggressive newcomers.

On the islands we have found the relics of more ancient times, but the problem now is to save them. The oldest of all lizards, the tuatera, once lived throughout New Zealand, but the rats and dogs brought in by Maoris and Europeans have killed them off except in some tiny offshore islands.

To save them, all visitors are barred, even the conservationists themselves. Yet it is worth the fuss, for tuatera still retains the third eye which all backboned animals once possessed, an eye that looks straight up through a hole in the top of the skull. It makes no image, but informs the brain of any passing shadow, or whether it is night or day, even when its owner is asleep. The rest of us have closed the hole, no longer have anything to see, and keep no more than a peculiar blob of pineal tissue deep between the brain, which, having nothing else to do, has been called the seat of the soul!

Yet life that reached the islands anywhere has gone on evolving or changing, and it is the small scale on which it has taken place which makes it easier to see. I can see my neighbour or my children, but not mankind at large. The mind can take in only so much at once. Darwin could see the mocking-birds and finches, but Humboldt in the Venezuelan forest was overwhelmed. What islands have done, as the finches have shown, is to demonstrate the effect of isolation, apart from the simple question of safety. Sports may arise within a certain population of animals and give rise to more of their kind. If there is free mixing and breeding throughout the population, the general character of the community as a whole may slightly change, but that is all.

But if part of a community reaches an island and sports arise there, the distance or the water interferes with travel, there is no mixed breeding with the rest of the community, and the islanders before long become so different that they could not breed with the mainlanders even if the opportunity arose. They become a distinct species. At the Galapagos the ground-finches a long time ago scattered themselves among the various islands. Being inherently lazy like all living things, each little island group fed and bred upon its own little spot of earth and lost contact even with those on the other islands ten to fifty miles away. And the sports that arose from time to time, on this island or that, never spread beyond the finch community of its particular island, until at last each group became so inbred and different that interbreeding with finches of other islands became impossible—and several species of Galapagos finches take the place of the original one and only.

Much has been written concerning the Krakatoa, the volcanic island in the East Indies which exploded late in the last century, destroying not only everything on the island from mammal to microbe, but causing an immense loss of human life by tidal wave for a far distance around. The volcanic dust drifted high in the air around the world and coloured the sunsets of Europe. Expeditions have studied at intervals the return of island life. Yet in its own way Narborough Island of the Galapagos, with its high volcanic dome and flat plain of lava, is just as fascinating.

The eruption of Narborough took place in 1825, half a century too soon to excite scientific curiosity, but it was just as thorough as Krakatoa. Four-fifths, at least, of the total area was flooded over with lava, and the cooling and solidifying surface, carried along by the flow beneath, buckled and broken, now forms the coastal shelf. It is here we see the first step in the conversion of a barren oceanic volcano into a green island. There is no soil to start with; it must be made, and lava is not the stuff to start with, as anyone knows who has walked the ridges of Oregon. It starts with the sea, the surf smashes the calcareous shells of the marine molluscs into gravel and sand and tosses it into the cracks and hollows of the rocks. Then and only then can the pioneering plants take hold. The mangrove finds its footing in the sand-filled cracks, an oceanic voyager as good as any coconut. Like coconuts, the mangrove seedling, the size and shape of a cigar, drifts with the currents and continually sails from the western shore of the Isthmus in the general direction of the Galapagos. At Narborough it is already lodged in the crevices, and the only other woody plant on the island lives where sand has been carried inland and where some protection is supplied by the mangrove.

The glassy ledges are covered with sea-lions and seals, the largest colonies of the biggest of the black sea-lizards, of boobies, black gulls, cormorants, and penguins. The sand, manured by all these, becomes richer, and grass and a cactus take their place beside the mangrove, and these in turn supply food for grasshoppers and crickets, and so it goes on. But small lizards which would be eating insects elsewhere seemingly couldn't wait and have turned to eating crabs. I suppose those that didn't, died—and have left no progeny. Yet the real life of the land has barely started and what there is is scanty in the extreme. But when the shore is no more than a resting-place and food comes from the sea, the animals abound.

All the life of Narborough is in the end dependent upon the sea, not on the warm equatorial current moving in and out along the northern edge of the archipelago, but on the cold Humboldt current swinging in its great arc north and west from the coast of Chile and Peru. Of all the sea-currents in the world this is the richest, and the sea-birds and sea-mammals of Narborough are there to take advantage of it. All they need besides the current is a little rock to rest upon, and that is what they have.

Dampier mapped the current of sea and air, Humboldt took its temperature and left it his name. For a long time the coldness was thought to come from the antarctic seas, and some of the water does come from the subantarctic west-wind drift. When it was recognized that the trade winds drove the coastal waters offshore and that cold water welled up inshore to replace the warmer water moving out, the guess was that it welled up from the cold, abyssal depths of the Pacific. This was closer to the mark, but it turns out that it comes from a moderate depth only, from about six hundred metres. Yet this is deep enough to do the trick.

The Humboldt Current is a name that can be used in two ways: it can mean the broad movement of water north along the eastern side of the Pacific, hundreds of miles wide, and turning in a broad, wheeling movement to the west, the current of the mariners, or it can mean the narrow zone of upwelling along the submerged steep edge of the Andes, together with its north-westerly seaward extension near the equator. This alone is the cold current and the one that is so important to the life of these regions. It is only thirty or forty miles wide.

The essence of it is this, that diatoms, upon which all the life in the sea at last depends, are themselves dependent on two items that are not always available—light and certain salts in short supply, those containing nitrogen and phosphorus. Light, in effective strength, penetrates only a moderate distance, and only within this depth can these microscopic plants live and multiply. And they can multiply only as long as the essential salts hold out, so that great areas of the ocean are as barren as a desert. The secret of the cold Humboldt Current is that water continually wells up along the steep, submerged edge of the continent from depths below the lighted zone, bringing up in continual supply the unused nitrogenous salts of the cold and deeper waters. And so the plants flourish.

With the diatoms in abundance, minute crustaceans and other small animals flourish in their turn, for it is a matter of size. Small crustaceans support larger ones and also the small fishes, and on these feed the larger fishes and the cuttlefish and squid. Then come sharks and whales feeding on the bony fish and cuttles, and from the adjoining shores the sea-lions and sea-birds join in the feast. This is the greatest of all "food chains", and it can be traced all the way from the astronomical causes of the circulating winds to the New England whalers in their heyday.

This is the origin of the Bird Islands of Peru, the largest natural source of phosphate and nitrate fertilizer in the world. Cormorants, pelicans, gannets, boobies, and other birds fish the cold current for anchobetas, returning to the islands only to rest or breed, and in the course of time covering the islands with a mass of white excreted guano a hundred feet in thickness. It is the white gold of Peru, and fortunately at present the birds are officially regarded as the layers of golden eggs. It wasn't always so!

Nowhere else on earth are the birds so dominant; every naturalist and many another who has seen them has stood in wonder at the sight, and I and the rest who have only read of them have at least one goal to live for! Otherwise, for vicarious enjoyment, there are the unbelievable pictures of Francis Jacques and superb descriptions in Murphy's *Oceanic Birds of South America.* Cormorants move over the sea in dark clouds, pelicans in seemingly never-ending lines, one behind another, and when the fish are thick the gannets and boobies dive obliquely at the water in a literal rain of birds. Even the little Peruvian penguins of the lower rocks get excited and swim in haste to the shoals of fish. Once they riddled the thick blankets of guano with their burrows, but not any more, and only in caves and under cliffs can they now be found. They are little fellows, and some of them must have made the equatorial but cold-water passage to the Galapagos, to change but slightly after they had settled there.

The Galapagos cormorant probably took the same course from the south Peruvian coast, and the Galapagos albatross, a distinctive kind that breeds nowhere else, must have fished its way along the current of life.

Once in a while, about every ten years or so, the south-east trades fail in their strength and winds from the north take over. The sea no longer is driven off from the shore and no deep waters need rise to replace it. The inshore belt stays put and day by day gets warmer and warmer. Then comes catastrophe. Not only do the diatoms die if the sea is too warm, but neither fishes nor shrimps can stand the rise, and death becomes universal. All die so fast the water fouls, ship bottoms become black with sulphur, and the dead life stinks under the tropical sun. And both the birds and the mammals begin to starve. "El Niño" has arrived! It has come twelve times since Humboldt trailed his thermometers, and with it comes the rain. In 1925 the Humboldt Current disappeared as far south as Arica, where Wafer and Dampier watched the boats while others fought, and in March alone the rainfall was ten times as great as all of the ten years that had gone before. With the rain the coastal deserts turned green and bloomed, and the island guano began to wash away. And as the waters warm and the cold life dies, tropical scavengers came from the north—hammerhead sharks and many others swim down from the tropics, thousand upon thousand, to make the most of the ill wind. What really causes "El Niño" we do not know, but the amount of antarctic ice in southern waters is not to be ignored.

22

EMPEROR OF ANTARCTICA

Both Europe and America were wide awake, excitement was mounting, and ships of all nations were on the prowl. The *Beagle* was no sooner back in England than an expedition set out from France under Dumont d'Urville, and the United States Expedition sailed under the command of Charles Wilkes, both heading for the far south. Cook's voyages round the world had disproved only the myth of a vast southern continent extending into temperate latitudes, and the persistent reports of whalers and sealers from that time on of points of land beyond the Antarctic Circle left the rest of the question open.

In 1838, a year or so after Darwin's return and Victoria's ascent to the throne, both d'Urville and Wilkes were poking into the southern ice-pack in western Pacific longitudes, and the most informative person they met was the emperor. The emperor penguin had already been seen but not recognized for what he was, for at the time of Cook's second penetration into high southern latitudes, just before the *Resolution's* frantic run north to Easter Island, the Forsters saw large penguins on the floating ice. Since then we have come to know that of all the seventeen species of penguin living in the earth, only two are truly antarctic—the small Adélie and the magnificent emperor, and it was the emperor they saw.

The first sign of land came well before the sight of it, for in January of 1840 Wilkes captured an emperor and found a quantity of basaltic pebbles in its stomach, not merely a sign of land, but pieces of it. Land must lie to the south, and he quickly found it, a section of Antarctica that now bears his name.

D'Urville brought back the egg of the emperor, probably found floating on sea-ice, and the land that he saw, next door to Wilkes and due south from Australia, he named for his wife Adélie. And the little penguins he brought home to Paris in 1841 became Adélie, after the land of their birth.

Ever since Columbus raced everyone across the Atlantic, including themselves, the English have prided themselves on leading the way in exploring the seas of the world. In 1831 Ross had gone into the north-west arctic and located the north magnetic pole. In 1839 he left England again to search for the south magnetic pole, in command of two ships of about three hundred and fifty tons each, the *Erebus* and the *Terror*. Arriving at Hobart, in Tasmania, in 1840, he was met with the news of the French and American discoveries, and preferring to fish in a pool by himself, he sailed far to the east before "steering as nearly south by the compass as the wind permitted". Land foiled him from gaining the magnetic pole, and instead he turned toward the true south, sailing along a coastline with a great line of mountains on his right hand. It was a fortunate turn, and for five hundred miles he drove deep into the antarctic, eight hundred miles beyond the circle—"with a favourable breeze and very clear weather, we stood to the southward, close to some land which had been in sight since the preceding noon, and which we then called the High Island; it proved to be a mountain twelve thousand four hundred feet of elevation above the level of the sea, emitting flame and smoke in great profusion; at first the smoke appeared like snowdrift, but as we drew nearer its true character became manifest—I named it Mount Erebus and an extinct volcano to the eastward, little inferior in height being by measurement ten thousand nine hundred feet high, was called Mount Terror. . . . As we approached the land under all studding-sails we perceived a low white line extending from its western extreme point as far as the eye could discern to the eastward. It presented an extraordinary appearance, gradually increasing in height as we got nearer to it, and proving at length to be a perpendicular cliff of ice, between one hundred and fifty and two hundred feet above the level of the sea, perfectly flat and level at the top, and without any fissures or promontories on its even seaward face." Ross had broken through the pack-ice into an unknown sea which now bears his name, to discover not only the mountains of Antarctica but also the Great Ice Barrier, and to penetrate by water to within less than twelve degrees of the pole itself. The naturalist on board was Joseph Hooker, then in his early twenties, who became the most famous botanist of his day.

Ross and Hooker combined in their zeal for collecting all the marine animals they could, the captain giving up part of his small cabin to promote the work. Quarters in general were crowded, and we have a picture of Hooker impulsively jumping down the main hatch with a penguin skin his hand, at the moment Ross was coming up. The skin survived, and three years later the emperor received its scientific baptism, as *Aptenodytes forsteri*, in honour of the older Forster.

On another throne Victoria became an empress, celebrated her jubilee, and the century passed. Hooker lived on into the next and saw the start and heard the finish of Scott's voyage of the *Discovery*, which sailed into the Ross Sea in 1902, setting the stage for the dash to the pole ten years later.

Wilson was the naturalist with Scott, though he was doctor too. Shackleton went along, and in 1903 the three of them made the first southern journey over the ice toward the pole, over the length of the Great Ice Barrier to the foot of the Beardmore Glacier, nearly a thousand miles there and back. They found the polar road over the barrier at the foot of the ranges, but scurvy hit hard, and Scott and Wilson were hard put to get Shackleton back alive.

Scott had no intention of remaining beyond the year, but pack-ice stayed at home and so did the *Discovery* and her people for another dark winter and cold spring, to huddle at the foot of Erebus and Terror. The volcanoes were on an island, not the mainland, as Ross had believed, but not too far away. Cape Crozier, named for the captain of the *Terror*, was its eastern extremity, and here starts the real story of emperors and Adélies.

Crozier is where the western edge of the ice-barrier squeezes into the sea, with all the mass and pressure of the greatest ice-sheet in the world moving behind it. At Cape Crozier the barrier ice piles itself up against the mountain, and, of all places on earth, this is where the Adélie and emperor penguins breed. There are other places, to be sure, but not where men have been.

Here is the scene, in Wilson's words: "We were on an old outlying cone of Mount Terror, about thirteen hundred feet above the sea. Below us lay the Emperor penguin rookery on the bay ice, and Ross Sea, completely frozen over, was a plain of firm white ice to the horizon.—The sky looked black and threatening, the barometer began to fall, and before long down came the snowflakes on the upper height of Mount Terror. All these warnings were an open book to the Emperor penguins—a long file was moving out from the bay to the open ice, where a pack of some one or two hundred had already collected about two miles out at the edge of a refrozen crack." Two days later "the change was immense. Ross Sea was open water for nearly thirty miles; a long line of pack-ice was just visible on the horizon from where we stood, some eight or nine hundred feet above the sea. Large sheets of ice were still going out and drifting to the north, and the migration of the Emperors was in full swing. There were again two companies waiting on the ice at the actual water's edge, with some hundred more tailing out in single file to join them. The birds were waiting far out at the edge of the open water, as far as it was possible for them to walk, on a projecting piece of ice, the very next piece that would break away and drift to the north." Only those that were yet nursing chicks still huddled under the ice-cliffs, sheltering as much as possible from the storm that was driving the ice out of the bay. The emperors went with it, but it was half a year later before the rest of the ice went out and allowed the *Discovery* herself to sail home to the north.

Wilson also wrote: "The possibility that we have in the Emperor penguin the nearest approach to a primitive form not only of a penguin but of a bird makes the future working out of its embryology a matter of the greatest importance"—a statement that caused no end of trouble, in the sheer physical sense of the word, both to himself and to others. The statement itself is the product of its time, and makes several assumptions. One is that the penguin is a primitive bird and has never known how to fly, which is more than doubtful. Another is that the emperor is more primitive, as penguins go, than the rest of these inquisitive manikins, and the third, which brought the trouble, is that if you look closely enough at the early stages of the embryo developing within the egg, you will see in some sort of outline a repetition of its evolutionary past. This idea is a hangover, not from Darwin himself, but from one of his ardent German admirers of the late Victorian age, Professor Haeckel, a man of immense industry and influence. There was a time, not so long ago, when zoologists everywhere were digging into the life-histories and embryology of every animal on land or in the sea that they could lay hands upon, with the belief that their individual stories of evolution would drop like ripe plums from a tree. It hasn't worked out that way, but Wilson was a little too soon to know, and the thought remained.

Ten years later he and Scott returned, once more within sight of Terror. This time the pole itself was the goal, and both men were to die on the journey back across the barrier. But before the polar journey started there was time enough for another, a search for fresh and not too old eggs of the Emperor, eggs that would be laid on the ice a hundred miles across the barrier in the dark midwinter of Antarctica. Three set out, Wilson as leader, Bowers, who also died on the polar journey the following summer, and Cherry Garrard, who tells the story. He wrote a book—*The Worst Journey in the World*—or "Winter Journey" for short.

They journeyed for five weeks. That may seem not very long, but it depends on how you measure time. By weeks it is little, by days not so much, but measured by minutes of exhausting effort, cold agony, and anxiety, with each dark and bitter and dawnless day a release from the frozen armour of unthawed sleeping-bags, the time becomes eternity. They hauled two sledges, each man pulling two hundred and fifty pounds, over a rough and tricky surface. After a while they could pull but one sledge at a time and had to travel ten miles to make three. At temperatures lower than sixty below zero they went back and forth in the darkness, tracing their own footsteps a few at a time with the aid of a candle, and otherwise steering by the light of Jupiter. In eight hours they accomplished two miles, more or less, with effort so great the mind could not escape, with no respite mentally or physically. Crevices became a nightmare, for they were iced over and any one of them could mean death. Moisture from their bodies froze in their clothes, and there came a time when neither by day nor by night did they thaw, and frost-bite found them even in their bags. Only once did they find relief, during a three-day blizzard near the end of the outward journey, when the temperature rose eighty degrees to nine above zero. With that the ice in their clothes and sleeping-bags turned to water, from the added heat of their bodies, and "we lay steaming and beautifully liquid" and went to sleep. The cold hell of Dante returned, and at times at night each wondered whether the others were yet alive. They did find the eggs of the emperor, after dark descents with ice-axes and ropes, five of them; three of them froze and survived the journey back, the other two were crushed in falls.

No brief account can give the feeling and impact of Cherry Garrard's description of the winter journey. The effect is cumulative, the communication superb, and you can find it among the Penguin books, obviously the proper place. There was a time when I read everything on Antarctica and wanted to go myself. I even got as far as being interviewed by the *Discovery* Committee, not Scott's, for I am not so old as that, but the whaling investigation that started in the mid-twenties and has not yet come to an end. The desire lingered on until I lived this journey in the reading of it. Now I can say with H. M. Tomlinson, it "cures me of an old desire; I do not want to be a polar explorer any more. The Antarctic victims appear to have had experiences for which such words as terror and anguish are inadequate, and to have entered a limbo, as did not a few soldiers, where the soul suffered, but was calm and dumb because its afflictions were beyond reason, so there was nothing to say."

The three frozen eggs became pickled eggs and were taken back to England. And you get a feeling they were dangerous to touch. It's not true, of course, but the fact is that of the three who brought them back, two froze to death the following year and the other was never again the man he had been. Of the scientists who examined the eggs, Assheton in Cambridge did a little work on them and died prematurely. They went to Cosser Ewart at Edinburgh, who did a little more and published a brief report, and died. And at last they went to Parsons at Glagsow, who examined and described them fully, and died with half the usual life-span left to go. I went to school with him.

What did the eggs show? They showed that a penguin is penguin all the way and that a penguin's egg is the means by which a penguin gives rise to another penguin. There is no recapitulation of an ancestral past, no light is thrown upon the origin of birds, the penguin fin is a bird-wing from the beginning and develops like one. Only the manner of feather development is peculiar, and that tells us more of what a penguin is than what a penguin was! Nor is there reason to think the emperor's egg could tell us more than the egg of any other penguin, for, whether or not the emperor is more primitive than the rest, all are ninety-nine per cent penguin and tell the same story. Which is—a penguin is a bird that cannot fly in the air but uses its wings to fly underwater, for that is what it does.

So what of the winter journey? Does its value stand or fall depending on what an embryologist sees in a bird's egg? I think not. The journey stands. The objective, an emperor rookery, had as much, or as little, meaning as the South Pole itself. In one case they heard the emperors calling and came back with three eggs, and a journey in which three men grew together in close spiritual bondage. And the account of it has stirred the hearts and minds of thousands. The eggs are not important.

Scott and Amundsen reached the pole, but Amundsen reached it first, and he returned and Scott did not. Yet one remains in the minds of men, and the other is like a date in history. Why? I think it means that the pole itself was not important, only an imaginary spot in a wasteland on which to plant a flag, like a cairn on the highest mountain—that Amundsen made a successful dash to the pole and back, and that was that. It was fast and efficient, but you cannot get into it. Scott and his companions arrived too late and were travelling too slowly for a safe return. They were in trouble and pulling together, welded together. One died on his feet, one walked to his death to give the others a chance, though they died in their tent in brotherhood and in concern for their kin. They wrote of what they had done, what they thought, and how they were dying. Their diaries I have known by heart. The pole doesn't matter, the journey stands.

Of all the south polar journeys, the most disastrous in terms of objectives unobtained, and the most stirring epic I have ever read, was Shackleton's voyage of the *Endurance*. His purpose was to land somewhere on the Wedell Sea coast, travel to the pole and keep going right across the antarctic continent to the Ross Sea. But the ship became caught in the pack-ice about three hundred miles offshore, was crushed and sank. Between twenty and thirty men with three small open boats, the largest of which was eighteen feet long, found themselves on the ice south of the Atlantic Ocean. Then came a journey back that will live as long as any. At first it was a matter of hauling the boats along the edge of the pack-ice, partly on ice, partly by water, for some hundred miles, ending with a short journey that landed them all on Elephant Island, at the south of the Scotian Arc. This was as far as the party as a whole could travel. There could be no hope of help unless word could be sent to South Georgia, where the Norwegians had a whaling-station. The longest and best of the three boats was rigged with a sail and half decked with canvas from the sails of the other two, and Shackleton with five companions set sail for South Georgia. The remaining twenty-two men stayed behind on Elephant Island living on limpets and seaweed, drinking water melted from snow by the warmth of their bodies, with no more shelter than two little upturned boats could provide, for four months. Shackleton sailed his small boat across the eight hundred miles of open ocean in the roaring fifties, to land on the south shore of South Georgia. Three companions were ill and were there left in the shelter of a cave, while Shackleton did what had never been done before nor since. They crossed the large and mountainous South Georgia, high among the peaks and glaciers, from one side to the other at night. There has been nothing like it. Those who are most familiar with the massive icy heights of the island find it the most incredible. Shackleton climbed and walked by day and by night over passes and across crevice-cut glaciers, and finally descended on the small Norwegian community. Whether or not he looked like Moses descending from Sinai, the first tough whaler to see him fled before the sight. And Shackleton has sworn that someone walked at his side through the darkness, that in some manner he was not alone—and T. S. Eliot, in *The Waste Land*, asks "—But who is that on the other side of you?"

The objective now, of course, was the saving of other men's lives, and the second attempt of a rescue ship from Montevideo to penetrate the pack-ice to Elephant Island brought them all off alive. But whatever the outcome, this one man's journey would have remained untarnished. I know it would for me.

Columbus sailed for the Indies, and our satisfaction in what he found is much greater than was his, and his later melancholy does not detract from his early venture, but merely puts it in sharp relief. The myth that was in his mind seems unimportant, other visions could have set him free to journey west into new space, and it is the quest that counts—*Kon-Tiki*, a mythological mix-up if there ever was one, drew the balsa logs from the Ecuadorian heights and sent a modern raft built on an old pattern drifting across the Pacific. The venture was magnificent, its portrayal entrancing, and the glamour of the journey has little relation to whether Polynesians came from the east or the west. The myth set the men in motion, and in another time they might have been the ones to find a continent. It is all summed up by Whitehead, the scientists' philosopher of the twentieth century—that the process itself is the reality—as in a melody.

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Where does all this leave the penguin? The figure of fun remains; so does the slickest sea-bird of them all, a marvellous conversion from flight in unsubstantial air to flight in cold and heavy water, for flight it still is, not underwater paddling or just diving. The padded body is streamlined for speed, the wings are hard and firm for beating against the liquid medium, chest-muscles and keel are heavy enough to operate them, feathers are modified to make a dry, insulating coat, and sea-water is freely swallowed in place of fresh. Below the surface the bird is as fitted to its place as any porpoise, fish, or squid—a lithe, darting, efficient animal with eyes well suited to seeing through water. Only the fast flips to the surface to get air gives it away, and even that is as brief as a fish jumping.

Out of water it is another matter. A penguin cannot fly and has to walk, but legs of streamlined swimming and diving birds are short and they are all a race of waddlers. Good sight underwater means poor vision out of it, for corneal curvatures are necessarily different, and penguins and sea-lions, for all their prowess as fishermen, are hopelessly short-sighted on the land. Which may be why penguins on the ice or climbing a more temperate hillside all follow the footsteps of the leader, trailing their way in long lines—it requires so little sight and thought.

Yet this myopia itself tells us something, if only we knew what to make of it. Visibility on a smooth ice-sheet is no more than three miles even for a man, for short-sighted penguins it is less, let alone when all distance is a blur. But they travel across extensive ice-fields in a direct line to their proper destination, and in the sea, in regions where the water temperatures vary little if at all, they migrate hundreds of miles without chance or equipment for making any celestial sights. If any birds really have a true directional sense, which we do not, the penguins have it. On these long treks they cannot see their way, smell their way, or feel their way. What is there left? I do not know—and can only wonder. Light may yet be important, even where vision is poor.

With most birds the sexes look quite unlike and the birds have no trouble. But not the penguin. Penguins look alike to penguins as well as to men and a hopeful male (penguin) never knows what he's starting. All he can do is to go up to a likely-looking individual and make an offering of a pebble or a feather—'Tis a small thing but mine own!—and hope for the best. If the offering is ignored, the recipient may be a bored bachelor or an unawakened maiden. If the supplicant gets a good pecking, he has picked upon a thoroughly insulted gentleman. Only when the pebble is graciously received does he know he has met the right kind of girl and the courtship can proceed. Sex is not flaunted.

Penguins define the Southern Hemisphere in circles, segments, and spots. Emperors and Adélies fringe the antarctic shore the world around—kings, johnnies, rockhoppers, and macaronis hold the islands throughout the west-wind drift—rings keep to the Scotian Arc, the jackass to Patagonia, Humboldts to his current, and the Galapagos to its island group. These are not all, but they will do. They keep within the cold water, but go wherever it goes, and the Galapagos Islands are the northern limit. From south to north, as sea temperatures rise, their size decreases, the emperor the greatest, Galapagos penguin the smallest, the others and their ranges between. It is a matter of weight, heat production, and body surface. At the ice-barrier it is hard to stay warm, at the equator one needs to keep cool.

Each kind has its own particular problems of food, home, and happiness, and not all of them are troubled with snow and ice. Adélie has come in for the most attention, as befits a lady, for she is comic and arresting, against the orthodox white antarctic background. Movies, books, and even radio have carried her fame and foibles to the world at large. Every polar expedition has found her good and inquisitive company. More than most, Adélies are travellers. They spend the winter on the northern edge of the pack-ice, and journey more than five hundred miles by water to reach the breeding colony at Cape Crozier, and a fair way by foot across the ice. On the ice they travel as fast as a man can run, either walking in short, quick steps or tobogganing on their breasts with wings and feet both pushing. Ice travel is by daylight only, at night they camp in line till dawn, and the ice journey may last two weeks. At the end of the trek the long lines break up, the birds fall on their bellies, and flippers and stern-wheeling paddle feet drive all in a noisy free-for-all for the final goal. As the long lines of migrating Adélies come to an end, the antarctic skuas arrive, the savage marauding gulls that are the greatest enemies of their eggs and young.

On arrival at the nesting grounds the hens stake out the claims, each bird slightly thawing the soil with her breast and scratching a circular scoop. Then she waits in amorous serenity for a mate. Newly arrived cocks being courting at once, but after the prolonged effort of their recent journey they are apt to go to sleep on their feet at any moment, to take a brief nap a dozen times or more while pressing their suits with the waiting maidens or matriarchs. If a hen likes the show, she may cackle back at the suitor, or she may give him a good pecking, which seems to appease her and merely makes the abused male more suppliant. They then assume the " ecstatic " attitude, cross their beaks, sway from side to side, and cry shrilly. After mating, the cock brings all the round pebbles he can find to make a stone rampart around the scoop, in the middle of which two eggs are laid. If stones can be filched from a neighbour, so much the better. The offended owner then seems to swell with rage, feathers erect and head plumage raised like a top-knot, and gives chase. The thief, on the contrary, makes himself look small and sleek and tries to lose himself in the crowd. And when one is recognized before the event, he quickly throws off his keen prowling look and walks nonchalantly by, as though nothing had been further from his intentions. But family life, once established, is usually tender, faithful, and affectionate, although some couples remain in squabbling bondage. There is a little too much comic caricature of human matrimonial behaviour in these birds for our comfort.

Peaceful family and community life, however, does not imply silence. Wilson wrote: "The noise is almost unceasing. From a distance it is like a whistling roar, and when we looked down upon the two hundred acres swarming with shouting penguins and their whistling, piping chicks, one was reminded of nothing so much as a rink with a thousand chattering skaters."

Turns are taken sitting on the nest and there is quite a ceremony when the guard is relieved, when the two birds rub necks together and softly cackle. Once off duty the freed birds gather in groups at the ice-foot to frolic and chatter, each one trying to make some other take the first plunge. Once it goes, the others follow in quick succession, though usually after a hasty glance to see if number one has encountered a waiting sea-leopard. This is their worst enemy underwater, more so than killer whales, which prefer the seals themselves. All danger apart from man has come to them from the sea, and it is hard to drive the penguins into it.

Once in the water, penguins progress by porpoising, travelling below the surface for ten to thirty yards and then shooting into the air in an arc of seven or eight feet, to vanish again with hardly a ripple. For the most part they feed on the opossum shrimp, the krill of whales—whale canapé, a friend of mine has called it—and like it so much that they will gobble until well distended, and, like Romans at a banquet, vomit and start all over. When finally full, or when scared to death, they head for the ice, break surface thirty or forty yards away to appraise the distance, submerge, and drive for the landing. And at the base of the ice with marvellous accuracy they shoot out of the water erect like a jack-in-the-box and land standing on ice five feet above the sea.

The birds that both Drake and Hawkins saw when entering the Strait of Magellan, were the jackasses, black and white harlequins with a wicked black bill. Magellan called them geese and Forster named them "magellanicus" to clinch his observation. And on land or sea they bray like jackasses and have much less sense. They burrow into unfrozen ground to make their nests, but travel far along both Atlantic and Pacific shores at other times. Robert Murphy thinks the ancient Magellanic penguins were the home stock from which some have reached half-way round the world—down-wind, down-current—along the oceanic routes of the Humboldt Current to Peru and the Galapagos, and east with the west-wind drift to South Africa and the islands of the Indian Ocean.

Even though nests are made in burrows, pebbles are still brought in, without apparent purpose. Maybe the pebbles are like diamonds: they signify a lot, but when all is said and done are only pretty little stones. In another way, however, the pebbles may have meaning. Jackasses in the water travel fast, more than twelve knots, in search of cuttle-fish, and old-time sealers and more than one modern observer have said they swallow pebbles as ballast when they go to sea and eject them on their return home. And these of course may be the pebbles in the burrow.

Perhaps the rockhoppers, or jumping jacks, belong most to the sea but look the silliest on land. Half impish, half scared, with puffed cheeks, crimson eyes, and a shining black crest, they step uncertainly with feet lifted high and have to jump to get anywhere in a hurry. They do not even dive into the water, but jump in feet first from the ledges. But they spend so much time at sea that they have been found with barnacles growing on their toes, and encircle the world in the west-wind zone.

When Cook first discovered South Georgia, the Forsters went ashore and brought back two kinds of penguins, the king and the johnny, both of the west-wind zone. Johnnies are timid, but they suggest something of the past. They are climbers, and for reasons best known certainly not to themselves, they cross perfectly good ground near the sea and trudge wearily up the hillsides to make their nests near the summits of shelterless ridges. There is nothing to be gained by this at present, though it may have made sense at one time. South Georgia, for all its present icy bleakness, was once buried under an even greater cap of ice, and during the long period immediately following its complete glaciation little breeding territory could have been available. What bare rock there was would have been the rocky ridges separating the ice-filled valleys. The johnnies have simply held on to the old instinct of climbing to the ridges to find something less disconcerting than ice upon which to hatch an egg. So they go on raising the feet high at every step, with heads thrust forward to see where they're going. After all, we're hardly out of the ice age yet, and in South Georgia there has even been an appreciable wane of the glaciers since the time of Cook and Forster. Moreover, the lower levels would have been held by the seals and the bigger and stronger king penguins. Such, at least, is Murphy's opinion.

Only a little smaller than the emperors, the kings have stature, dignity, and colour. It has been their fate to suffer more senseless slaughter at the hands of white men than have any other kind. All the residents of the last rookery in West Falkland were boiled down by a shepherd to get oil for waterproofing the roof of his house, which puts a higher value on the survival, let alone the comfort, of a man than was ever intended. The bird still survives on South Georgia and the west-wind islands, but not in the old numbers.

King penguins breed on low ground among the tussock grass or on bare and bleak moraines with snowbanks and a glacial torrent close at hand, chilled by the wind that sweeps continually through the colony. They might do better, but once again it may be a case of behaving as though the ice age was still in full force, for the kings, like the emperors, hold the egg in a pouch at the base of the belly, even though it is easier now to avoid ice than find it.

So at last we come back to the emperor. Of all birds it is the most truly antarctic, the tallest, heaviest, biggest-boned penguin alive, standing as high as a man's chest, and except at the Scotian Arc remaining always within the Antarctic Circle. Yet for all its size and weight, it can shoot up from a depth and land feet first upon ice its own height above the surface. It is a powerful bird. Five seamen from the whaler *Baleana* caught one and tried to hold it down, but were scattered like ninepins. When at last they managed to strap two leather belts around its body, and stood back for a deep breath, the emperor did the same and burst the belts.

West-wind birds have short winter days in which to fish, but the emperors live through six months of darkness. Stars send little light into the cold, black waters in which they fish, so how do they find their food? What use are eyes in the dark, and what bird has a good sense of smell? I would hate to have to find out—one Worst Journey is enough.

All through the long polar night the loud metallic trumpeting of the emperors can be heard afar, and throughout that long and bitter darkness they cuddle their eggs and raise their young. With the coming of light in the spring it is all over and they are off fishing from their ice-rafts. The great problem is not how to produce enough eggs but how to incubate them and raise the chicks. The procedure is clear enough, though how it is brought about is another matter.

This is what happens, and it shows extreme adaptation to ice-bound conditions. Only a very small fraction of the emperors breed during any one winter, but all individuals of either sex, mated or not, have a warm pouch and a warm heart for any exposed egg or chick. The whole community feels broody, and even a lump of ice or a dead and frozen chick is better than nothing, and father, mother, or foster-mother tucks its egg on to its feet clear of the ice, within the folds of the pouch next to warm, bare skin. The system works, and enough offspring are raised each black winter in their icy retreats to maintain the population.

How it works we do know a little about, though not from studies on inaccessible emperors. Recent research on fowls, pigeons, and rats suggests that it is all a matter of glands and hormones. The hormones of the pituitary gland beneath the brain seem to be responsible. One of the pituitary secretions stimulates the ovary and regulates the egg production. Another puts a check upon the process and at the same time induces broodiness. Injection of it will cause a virgin rat to cuddle the young of another. In birds it is obvious that egg-laying must stop before broodiness begins, and these two pituitary secretions determine that it happens this way. And all that need happen to emperors is an excessive production of the second and a partial suppression of the first secretion, so that few eggs are laid, but there is a superabundant broodiness.

Emperor eggs told little beyond who laid them, a most non-committal statement. Skeletons of modern penguins suggest what certain quirks of penguin customs also do, just a whisper loud enough to tell which way to look, that penguins have blood relationship with cormorants and pelicans. Only when the past itself is added to the present and their voices heard in unison does the answer come clear enough, and only after travelling through space and time.

It starts with a journey to Patagonia not so long ago, by George Gaylord Simpson to collect fossils where the sea used to flow. The harder work came later at the American Museum of Natural History when thought and bits of bone were put together, and among the things he found was by far the best of the penguin fossils known to date.

Three general views concerning penguin origin are generally held, although none is new, and all three recognize that in some ways penguins are so unlike any other birds that their separation from the rest must have happened a very long time ago. One would derive the penguins directly from bird-like reptiles that had never learned to fly, another from flying birds so ancient that it is foolish to look for connections with any other kind, and the third from a remote but common ancestral stock from which cormorants and their relatives also came. The first of course is all tied up with the idea that two-legged running reptiles flapped their arms to gain additional speed and in the course of ages took completely off the ground, in contrast to a bird origin among woodland branches. And all assume that penguins as such came into being on the antarctic continent. The history of birds and the history of Antarctica both come into the picture.

We grow into the world as we find it, and are inclined to feel that what is has always been, apart from obviously human turmoil. Polar ice-caps are taken for granted; it would seem strange to be without them. We are ready to believe that the northern ice came farther south at one time and that old Stone Age men hunted its mammoths and got nipped by its frost. But most people, and I among them, have felt that ice-capped poles are the normal state of affairs, and even if at times all the ice has melted, it hasn't been for long. This, it seems, is far from the truth. Ice ages have been few and far between. The last, from which we are now emerging, started a little more than half a million years ago. There may have been one in the Eocene period, about sixty million years ago—the evidence is not clear. And there were ice ages in periods approximating two hundred and fifty, five hundred, and eight hundred million years ago. In between there may have been some ice at the poles, but for most of the time the poles have been cool, but not ice-bound.

There is the setting. Polar ice-sheets existing from the present to no farther back than a million years. Beyond that for an infinitely longer period there can have been little or no polar ice, and forests grew on Antarctica. The Patagonian penguin fossil, and fragments of many others of its kind, came from marine deposits of Miocene age, laid down about thirty million years ago, when the sea lay far across the South American continent, and we cannot invoke the antarctic ice to help us re-create a penguin. Of if we do, it must be one much farther back in time, which is not impossible, but is not needed. For only the emperor and king penguins, with their egg-cuddling apparatus, show evidence of glacial adaptation.

We are left apparently with a continent of Antarctica at least partly green, surrounded by seas undoubtedly cold but not ice-ridden, and girdled by islands of a west-wind zone a good deal more temperate than now—like a milder Tierra del Fuego, on which a warm-blooded creature might live without shivering—all set in a cool ocean as abundant with marine life as those seas still are. All fossil penguin remains found so far lie within these present penguin limits, and we do not need to look elsewhere for an origin.

Look at the three theories again. They can be put a little differently. The first means that the ancestral bird took to water and became perfected as a swimmer without ever having flown, the second that the birds once flew but became grounded and then converted a degenerate wing into a swimming organ, and the last implies that a flying sea-bird became an underwater flier without reference to the land at all.

What the emperor eggs and all studies of penguin anatomy emphasize is that the penguin is all bird, with typical flight mechanism and no sign of degeneracy. So out goes the running reptile theory.

The second theory had the support of the late W. D. Matthew, one of the great of the American Museum of Natural History. It has a strong appeal because of the pictures it calls up—that the ancestors of penguins flew to the land of Antarctica a long time ago, found no enemies or competitors or ice, and like so many other island birds having no need to fly, became too heavy in body and small in wing to do so. And in the course of time, as the land became colder, some of them took to making offshore fishing expeditions and used the short wing as a flipper. When the ice age finally arrived and the whole region was buried under the ice-cap, only the fishing-birds survived. It's all very beautiful and I have dreamed on it at night, but Simpson offers the remaining theory in a streamlined manner that is utterly convincing.

There are several striking features concerning penguins which have to be explained. The foremost, of course, is the type of swimming, which is submarine flying, and it seems that the penguin flipper has never stopped being a wing, but has only changed from beating air to beating water. This in itself requires a change from a long and broad weight-lifting blade well feathered to grasp the unsubstantial air, to a short, narrow, sturdy one that can be driven hard and fast against resisting water. All the changes in the wing and chest come from this.

Diving petrels are in many ways like penguins, except that they can still fly in the air. When moulting their quill-feathers they cannot fly at all, but are still able to use their wings underwater and catch their food as usual. They have, in fact, carried underwater flight just as far as it can go without losing aerial flight altogether, and Simpson argues that at this point a bird is compromised. The diving petrels have balanced one medium against another, and to go any further with underwater flight would mean loss of the other kind. This the penguins did; the advantages of perfecting submarine flight outweighed those of aerial flight, and they have gone all the way to perfection below the surface. With it has come the streamlining of the body, a change in nature of wing-feathers, and the peculiar placing of the legs, all leading to underwater speed. Insulation of the body by downlike feathers and by accumulation of blubber is part of the aquatic adaptation, not a relic of polar exposure. While the peculiar method of walking upright on land is the natural consequence of the swimming function. Simpson thinks that penguins took to the sea, not to escape terrestrial enemies or because food failed in their antarctic home—the two most popular theories—but like other oceanic birds because the fish, squid, and crustaceans in the seas around them were so abundant as a source of food. They became specialists in catching it in the cooler southern waters, and bred on the islands of the west-wind drift and even on the American mainland. Their greatest enemies came from the sea, not the land, and it is this fear, he thinks, that makes them climb hills, to get away from dangerous beaches where sea-leopards can still catch them, rather than an old instinct to find rock among long-forgotten ice.

This is the heart of it, and it makes more sense to me than the resurrection of pre-glacial Antarctica. And it leaves the emperor in a different light, not as the last embittered monarch clinging forlornly to his frozen realm, but a polar explorer from a more temperate earth, invading the ice-barrier and holding fast to his encampments.

23

AMERICAN SYMPHONY

JOURNEYS TO the poles are losing their point, and a voyage round the world means a travel agency more than the spirit of discovery.

The space of the planet has lost its mystery, though it's all we have, and we have need of all its beauty. The lands are filled, and men now wander from one to another for the sake of change, escape from boredom, or for a new home. The physical journey has lost its danger, and a new world's flavour is losing its strength. Yet the wonder of the journey grows with every passing year. We reach through space and into time in ways we never dreamed of. And as the facts pour in, about the present and the past, our little histories seem to fade before the greater drama.

The American story goes back not merely to Columbus or Eric the Red, not to the Mayas or the Basket-weavers, not to the uplifting of Patagonian beaches or to dinosaurian monsters a hundred million years before, but all the way to the time of emergence of life from the waters on to the land. It becomes the history of the whole terrestrial earth. Yet part of it became purely American, an epoch in itself.

We live in the age of mammals, to which we have full rights, though we have come but lately into the picture. This is the age that most concerns us. It is the age in which an unfamiliar world becomes the one we know, and starts about seventy million years ago, when primitive mammals, both pouched and placental, had already spread across the earth with the stage more or less to themselves.

It is like a play in three parts which all proceed at the same time but on different places on the stage, with only occasional passage between one place and another. Or like a symphony in which three themes are separately composed, and in various ways and periods are interwoven. One of the three is a South American melody alone, for the bridge at Panama was broken even before the Eocene, the Dawn Age, and the continent was an island for some sixty million years, long enough for any theme! North America and Eurasia made the other two, each producing its own, but with mutual contributions. And right at the very end when the final fusion comes, the strident music of the north drowns out the softer southern strains.

We need the picture of the play as well as of the concert stage, for it is a play presented in six acts, each known by its name better than by a number. The duration of the play is about sixty million years, or a little longer, and if we confine a million years within a minute we have an hour more easily comprehended.

Here are the sequences. The curtain rises on a Paleocene setting, a quiet period lasting ten minutes; Eocene, the dawning, follows it and lasts seventeen; three acts follow, with mounting tensions, the Oligocene, Miocene, and Pliocene, lasting nine, fifteen, and nine respectively; and, as the clock strikes, a final one-minute act runs overtime, the Pleistocene, when we ourselves come into view.

Here is the reality. The Panamanian Isthmus broke in the early Paleocene and let Atlantic waters into the Pacific until the beginning of the Pleistocene, for almost the whole of Tertiary Time. For all of this period South America remained isolated and the life within it went its own way, except that about half-way through the period of isolation some Central American islands formed which served as stepping-stones for certain northern animals.

North America and Eurasia remained joined by land at the Bering Strait for most of the time. There was a break during the middle of the Eocene, not of long duration; a longer break that persisted throughout the Oligocene, and shorter ones at later times—a case of off again, on again, and now it is off.

At times the world has been divided, at others it has been one, and there is no need to conjure up drifting continents, no need to suppose that there have been equatorial land-bridges between Africa and South America, or to think of an old continent splitting from pole to pole and the Americas drifting away to the west, to account for peculiar distributions of animals and plants. We have for too long seen the map of the world as Mercator's projection, or something of the kind, which emphasizes the equatorial view and makes the poles nonsensical. The aerial map of the north, with the pole in the centre and the continents spreading toward the sides, shows the obvious course of travel, and should be our guide in more ways than one.

In the beginning of our mammalian time we find Asia and North America occupied, now that the dinosaurs were gone, by two basically distinct groups—pouched marsupials and placental mammals. Africa, Europe, Asia, and North America were all fully joined in the north, there was a true World Continent, and both the groups of primitive mammals were spread far across the earth. South America, still joined to the North, received its quota, and this is our starting point —Simpson is the conductor.

The first scene is in South America from the time of its Paleocene isolation until late Eocene, when some new-comers arrived. From the original immigrants from over the bridge we find three groups evolving. One of them, the marsupial opossums, gave rise to arboreal and insectivorous kinds that still survive, and rodent-like forms and flesh-eating carnivores which now have gone. Of the other, primitive edentates of a kind no longer living gave rise to armadillos and giant glyptodons, to great ground-sloths and their descendant tree-sloths, and to ant-eaters; while primitive herbivorous mammals produced a whole series of grazing and leaf-eating animals, all now extinct and with only Latin names, a sort of caricature of what herbivores became in other parts of the world, with an imitation horse and something like an elephant. All these were cooking in the South American pot.

Two further groups of animals suddenly splurged across South America at about half-way through its period of isolation—rodents and monkeys. The rodents especially have caused a lot of headaches. They are very different from the modern rodents of North America, and the only other group of rodents that seemed to be closely related are confined to Africa. How could they have got from Africa to South America? Some favour a temporary land-bridge, others have thought the division of the group was evidence of a splitting off and drifting of a continent. You might as well evoke the devil to crack a nut, the more so since so many other prospective travellers failed to get across. Simpson, on the contrary, believes that some recently discovered fossils show that certain of the primitive World Continent rodents managed to reach South America in the late Eocene, and by evolution within the continent gave rise to the giant and other guinea-pigs, and later to porcupines. They could have made the crossing from north to south by settling on and drifting from one intervening island after another, and their resemblance to the African group comes from evolution along similar lines, no more and no less startling than the case of the imitation horse.

The South American monkeys are in much the same boat. They seem to be as definitely monkeys and as advanced as those of the Old World, and again some have thought they managed to get across from Africa, although they are distinct enough from the African kind. Only the New World monkeys have prehensile tails and widely separated nostrils, with other features that set them apart. It seems more likely that once again a primitive type that lived in North America worked from island to island to the south and made the final landing.

Yet neither primitive rodent nor prosimian monkeys walked across a land-bridge even from North America. If there had been one, they would have had many other companions. At the time of their southern arrival there were a series of sea-ways where Central America now stands, interrupted by islands, and small arboreal animals such as these were just the kind you could expect to survive short passages across warm seas on drifting trees or jungle rafts.

This is all of it, and for about another thirty million years the southern continent received no more. But the land itself moved up and down, and up again, while its living plants and animals continued to evolve and interact among themselves. During the Miocene, and for most of it, the Atlantic Ocean invaded Patagonia, lapped at the base of the Andes, and flowed well into the continental heart. Then the land began to rise, the sea drained off, and Patagonian terraces took its place. And more time passed. Yet far to the north the things to come were shaping.

The northern scene is like two rooms connected by a revolving door allowing passage each way except when on occasion the door is locked. For most of the time there was plenty of space, for there was no ice-cap intruding from the north, and the land was passably warm as far as the Arctic Ocean. Yet whether or not it was open, the road across the Bering Strait was more or less a bottle-neck, and Asia and North America each produced its own creations.

The stage is vast—far greater than the South American—the actors legion, and most of them gone before the play is over. Their bones have been unearthed from Spain to Guatemala, the long way round. At the American Museum of Natural History, Henry Fairfield Osborn, W. D. Matthew, and W. K. Gregory surveyed them all and mapped the age of mammals. Roy Chapman Andrews journeyed as far as the Gobi Desert of Outer Mongolia to find its beginnings. Simpson extends the study, and his recent book *Horses* as an event in several dimensions, is as much a journey into wonder as any voyage around the world.

For a time, perhaps for the first quarter of our hour-long play, Asia and North America remain a single theatre. The primitive placental mammals succeeded better in certain ways than others, and we find the grazing vegetarians taking on the forms of the two great modern groups, those leading to cloven-hoofed runners and those leading to single-toed runners. The early stocks of both of these flourished on both continents. Then came the northern break, for some million years during the middle of the Eocene, which gave each continental group its chance to get set in its own way, and the courses taken were continued long after the reopening of the door.

For a long time, in both continental areas, change went on, and the land teemed with animals as big and diverse as most of those we know, but none of them lives now in any familiar form and the list of their names is appalling to all but the specialists in fossils. At least I find it so. Then the door closed again and stayed shut throughout the Oligocene for another ten million years. At the end of the period most of the animals are still strange, but the foreshadowing of our world is there, and some are recognizable.

On the American stage alone we find both horses and camels of various kinds, all products of this land, though not yet the ones we know—horses were still three-toed. Great cats, including sabre-tooths, and bear- and dog-like animals with slashing teeth preyed on the vegetarians, not only here but in Asia too, different kinds in different hemispheres. Deer and antelope appeared in Asia, prong-bucks in North America. In the Old World alone, in place of the horses and camels perhaps, tapirs and rhinoceroses, and elephant-like mastodons took the stage. And in Africa certain apes showed human traits.

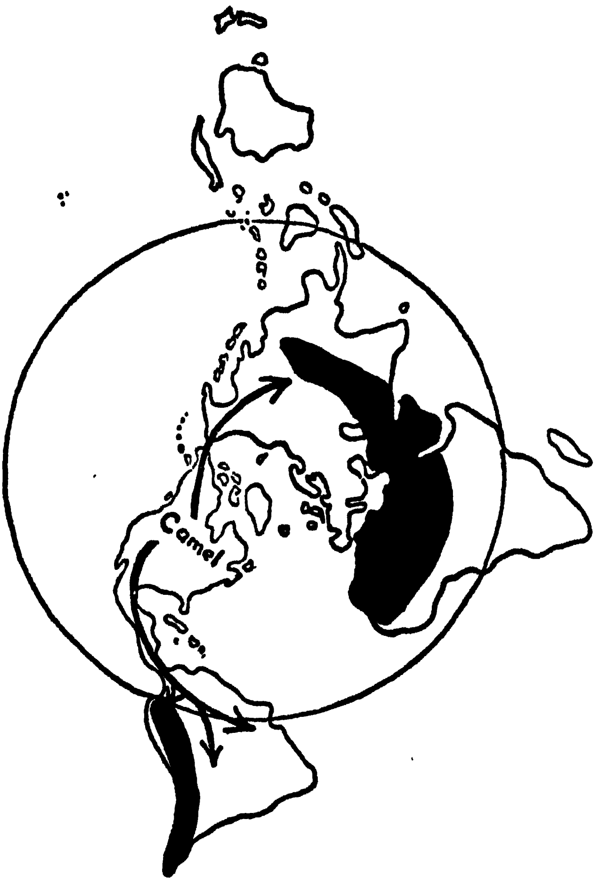
As the Miocene period ran its course and the door stayed open, the better travellers journeyed from one world to the other—the horses and camels crossed from Alaska into Asia and spread across the continent to Africa and Europe, while, moving east instead of west, the tapirs and rhinoceroses, and some mastodons crossed from Asia into North America. In a general way the two continents became much alike, and stayed this way throughout the Pliocene.

Slowly the stage was set for invasion to the south. North American plains saw widely ranging herds of horses, drier parts had camels; the rhinoceros was common. Tapirs and heavy-tusked mastodons pressed south among the warmer forests to the Central American region, and with them went the sabre-tooths. Filling in the background were peccaries and rabbits, squirrels and mice, raccoons and newly formed bears, and, lately from Eurasia, several kinds of deer. And, as the clock begins to strike the hour and the Pliocene period comes to its end, the gaps between the islands begin to close—and the bridge from North to South America rises slowly above the sea.

As the bridge clicks into place, animals from each side start moving across; a few even jumped the closing gaps, racoon-like tree-animals from the north and ground-sloths from the south made the crossing before the land became continuous. Even when the bridge was fully formed, invasion was slow. It went on past the hour, well into the Pleistocene, into the last minute of our shortened time. Few of the southerners succeeded in making the northern trek: the porcupine and opossum are exceptions, and their final success may be a consequence of their tree-climbing habits—it is so much safer off the ground.

The main invasion took place from north to south, and the gentler southerners to a great extent were overwhelmed as the full surge of northern forms fanned out below the Isthmus. The reason is fairly clear: the flow and counterflow between North America and Asia that went on intermittently throughout the Age of Mammals produced specialists in invasion and in meeting invaders—shock troops, in fact. Whereas in South America internal competition was pretty well over when the age was half-way past, and like all contented societies that have been secure too long, their defences were weak and gave way before attack.

The great assembly of hoofed grazers and browsers of the southern continent disappeared like chaff before the wind as the horses and deer swarmed across the savannahs and woodlands. The native kinds were dispossessed, generation by generation, by better grazers, better breeders, more determined types. The flesh-eating marsupials were no match for invading cats, bears, weasels, racoons, and dogs, couldn't compete for food, and probably were eaten themselves. The native rodents and edentates did not disappear, but squirrels,



rabbits, mice, and peccaries moved in among them and greatly reduced their numbers. Camels went in along the highlands, and live there now as llamas. Tapirs and mastodons went in too, and wherever the mastodon went, Smilodon the sabre-tooth trailed along behind. The safest place for the native born was below the ground or in the trees; armadillos, monkeys, and tree-sloths survived.

With the World Continent completely re-established and the past time all but gone, I feel this should be the end of the story. The rich fauna we now think of as being African belonged equally, with some variation, to Europe, Asia, and North America. A great part of it reached South America to live side by side with the survivors of invasion. North America lacked some of the Asiatic kinds, but was richer for opossums and porcupines and even ground-sloths and glyptodons. Horses, camels, and mastodons ranged across Asia and down through both Americas. Some animals failed to cross the bridge, for there was a barrier still, as well as a bridge, and where the tropical forests ended in the Mexican plateau, migration was a problem. The rhinoceros couldn't take it and remained in the north with others as well, while anteaters and sloths, armadillos and guinea-pigs stayed in the south, north of the bridge but south of the heights. It should be the end, but it is not, for the end is twisted. Someone, I think, has said that there are only two prophecies which can be safely made about the future of life, that it will be highly dramatic and entirely unexpected, and so we find it.

The clock strikes the hour. The Age of Mammals reaches its climax. The mastodons that started their career in northern Africa are spread throughout that continent, through Europe, Scandinavia, all of Asia from Borneo to Siberia, through North and South America from the Arctic Ocean to Newfoundland and south to the Magellan Strait. And by no means are they exceptional! Everywhere the land is warm or temperate. The poles are getting colder, but not enough to matter.

Then the hour is past, the age is over, and on that scale of time another sixty seconds brings us to where we are. It's not much, as time goes—only a million years—but a lot happens in it.

When temperatures are critical it takes a very small drop to start an ice-cap. As long as all of a season's snow melts during the summer, no snow or ice accumulates. But as soon as the summer heat fails to melt it all, it stays, and year by year gets greater. It starts in the highlands, and year by year spreads lower and farther. Ice forms beneath the weight of snow, glacial islands slowly extend, and finally join together. Ice flows slowly from the northern heights and creeps half-way to the equator. The living world gives way.

You can picture the process of retreat. It is not a case of waiting till your toes get pinched beneath the edge of an advancing glacier. Long before the ice is seen, the climate changes. Trees get stunted and grow more slowly, much vegetation goes completely, food and shelter disappear. The old climate goes farther south, and animals that depend upon the conditions it supports withdraw to the new line of safety. Few, if any, stand and fight, for it takes too long to breed new species able to succeed. Retreat comes first. Counter-attack from marginal ground may come later.

The ice came quickly, once it started, from massive centres over Greenland and Scandinavia, invading America south to Chicago, with subarctic climates extending far beyond its edge. As the polar cold spread south, the Temperate Zone moved also, and the tropics narrowed. What happened to the animals depended on their kind. Warm, wet forests where tapirs lived disappeared from almost all of the Northern Hemisphere, and with them went the tapirs. Now both forests and tapirs survive in their more restricted climate, south of the Tropic of Cancer in the Americas and South-east Asia. Some animals disappeared entirely, others half-way stood their ground, but all in all the mammals had had their day, and their glory began to fade. Africa alone held the wealth that had once belonged to the world.

The chill winds blew across the northern lands long before the ice arrived, and when glaciation eventually came, a quarter of the Pleistocene had passed. And when it did arrive it stayed with a peculiar rhythm of advance and retreat—roughly sixty thousand years of ice, sixty thousand years without, sixty thousand more of ice, two hundred thousand of withdrawal, another sixty thousand glacial years and sixty thousand interglacial, and a final glaciation of from one to two hundred thousand years, with three milder periods contained within it. Then for twenty thousand years the ice retreats again, and we are here. What is it we are coming out of—a wobble in the last glaciation, a true interglacial period with fifty thousand warmer years ahead, or is the ice age coming to its end? I have my doubts about the last, for in the face of this calendar we could be merely a quarter of the way from one glacial period to the next, and nothing yet suggests the rhythmic glacial beat has ended.

How far the glaciers withdrew during the interglacial periods is difficult to answer. It may have been more or less than at present and undoubtedly varied. South of the line of ice, during glacial extreme and northern withdrawal, whereever it was, arctic tundra gave way to treeless plains or northern woods, and these to temperate forests. The bands of each moved north and south with the shifting climates.

For those that could stand it the colder zones offered plenty of space and adequate food, and some there were that took advantage of it. Reindeer and wolves and bears appeared that could venture farther north, rhinoceroses gave rise to a woolly kind that could stay warm in a colder clime, and bison arose that spread through the plains and forests of all the northern continents. As the ice came and went and the plains and forests slid from one latitude to another, these cool-accustomed creatures ebbed and flowed like an ocean tide. And like the tide, the sea itself rose and fell as water alternately froze and melted. As the ice-caps formed, grew in size and imprisoned water, the level of the sea sank lower and lower—six hundred feet lower than at present during the greatest freezes, three hundred during the lesser. Now, as the ice continues to melt, the sea is rising still.

The rise and fall of the ocean as the ice-cap wanes and waxes is important. When the sea is low, the Bering Strait is dry and passable. It never has been under ice and at many times during the Pleistocene the door from Asia to America has been open wide to travellers from the Temperate Zone.

Bison cropped their way from west to east and horses from east to west. A few crept closer to the icy rim than others and braved the arctic winters. Musk oxen occupied the land from France to Kansas and Kentucky—now they live only in northern Greenland, the arctic islands and the Northwest Territories. The musk ox hasn't changed, it has simply moved with the retreating ice. But more than any other, the one that made the most of a frozen world was the woolly mammoth.

Like its relative the mastodon the mammoth's story started long ago and far away. Mastodons and elephants came from a common stock, but followed their separate but similar evolving courses to somewhat similar ends. The mammoths arose from the elephants as the ice age came into being, by covering their grey nakedness with long, thick hair. They were no less elephants for all that.

We find their bones everywhere where the ice once has been, stinking carcases even now are thawing out of melting glaciers and recently frozen ground, and their portraits are on the walls of the caves of Stone Age man. The sea now flows over places where they used to walk, and occasionally astounded fishermen haul up mammoth bones in their nets with fish from the floor of the shallow North Sea. Thousands of ancient skeletons have turned up all the way across Europe and Northern Asia, and the heavy-stepping pachyderms crossed the Bering bridge to North America. And thoughout the ice age mammoths symbolized the scene: the large Imperial and probably hairless mammoth of southern North America, the Columbian mammoth of the temperate plains, and the Woolly mammoth in the cold white landscapes of the north.

The Age of Mammals is past. The white curtain fell, and the curtain-call shows many of the actors gone or going from the stage. Another play commences and a new player comes into the scene.

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MAN IN THE MIRROR

WHATEVER ELSE a man may be, he is a mammal, and mortal like the rest. His bones lie scattered and buried across the earth. And the greatest treasure a fossil-hunter can find is a human skull that is older than the present species. For skulls are moulded by brains and reflect their size and structure, and it is the brain that counts. If early men fell into tar-pits or died in numbers in muddy swamps, we should know much more about them. But they did not. They walked alone and circumspectly, were not too numerous, and did not often die in such a way that later men could find their bones. Yet some do turn up—a small number, it is true, but enough, if taken at face value, to give a sketchy outline of the story. There were men on earth during the first phase of the Pleistocene, before the ice age started. Not Homo sapiens or even Homo, but some that were human enough to have been recognizable, and they were so human even then that they must have had a history dating much farther into the past than that, far into the Pliocene. Men of a kind came into being between the Miocene and Pleistocene, along with elephants and one-toed horses. And several kinds of men persisted till the ice age came upon them.

This is the beginning, and it lies somewhere in Central or Southern Asia, with Europe quickly added to the scene. Human skulls and other bones are studied just like those of other creatures, require the same industry in discovery or excavation, the same intensive scrutiny to reconstruct the whole. It is simply the study of fossils applied to our own kind. There was a time in the past, say five million years ago, when nothing we would call human existed, and a later time, between one-half million and one million years ago, when men looked enough like men for us to claim them. But even these were not the ones we know. These, ourselves, come later, and all men now living, white, Negro, Mongol, or Australian aboriginal, are but races of one species. Its name is Homo sapiens, meaning "wise", which is a name no one else would have given us.

Journey into time in many ways holds greater wonder than journey into space, I suppose because it is the fourth dimension and there is a greater strangeness. And when it is our own foreshadowing that we probe, the interest deepens. Little by little the human past is coming to light, and what and where we have been has determined much of what we are.

Men of a sort were walking erect before the ice age, in the Pleistocene, it is true, but in the early part of this period more than half a million years ago. The skull and other bones of so-called Peking man, with others known as Homo erectus, show this, and, further, that he used implements of stone, of antlers and bone, though of the crudest possible sort.

In a general way we know much more about what the primitive people did before and during the ice age than we do of the men themselves. Their stone tools have survived much better than their bones. Hand-axes and certain kinds of stone flakes come first, in various places and in various earth strata representing enormous periods of time. These axes served for digging up roots and grubs from the ground, rather than as weapons, and the flakes had strong cutting edges and many were hollow scrapers, particularly suited for working wood. Both these stone industries belong to the milder phases of the ice age, and indicate peoples of forest and woodland. They were a conservative crowd, and must have kept within the shifting forest zones, for there is almost no progress or any change in their stone-chipping technique for about three hundred thousand years, from early in the first glacial freeze until far into the long interglacial period of the mid-ice age. Other types of flake industry come later, with flakes or blades better suited for cutting and preparing carcasses, which belonged both to cold and to interglacial periods, as you might expect from hunters. One of these commences in the long interglacial interval and has survived in South Africa all the way to modern times, another turns up later, in the last interglacial, and appears to have been the product of Homo neanderthalens, a species of man in Europe whom sapiens may have absorbed. Neanderthal men undoubtedly dominated Europe during the last interglacial period and the first phase of the last glacial. Then our own sapiens migrated in force from the Middle East and took over.

Until recently Homo sapiens was thought to have come into existence during the last glacial period, that he was the last actor to appear upon the human stage, but a skull was unearthed in southern England just before World War II which changes the picture considerably. It is known as the Swanscombe skull, and it places our own species as far in the past as the Great Interglacial, placing us upon the earth as much as a quarter of a million years ago. And it begins to look as though the hand-axe people, who go back twice as far at least, were our own forefathers, and not side-lines which became extinct. It is also pretty evident that there has been a thorough forging amid the ebb and flow of ice—a repeated challenge and response throughout our human history. No wonder we feel at our best in a sharp, invigorating cold, for such was our cradle.

You cannot dissociate a man from his place, and an interest in one means interest in both. We trace our path through the ice age, and we cannot but wonder what brought the ice upon us. And the cause must either lie within the earth or somewhere outside of it.

What external rhythms are there? We base our clocks and calendars on the rhythms we know, on the day of the earth's rotation, the month of the moon, and the year of the season's sun. Night and day, winter and summer, have an astronomical basis, why not an ice age? For there are rhythms with longer periods, which come from the mutual attraction of the planets as they swing around the sun, each in its particular orbit. The tilt of the earth, which brings about the seasons, varies through three degrees in every forty thousand years. The orbit of the earth is elliptical, and the sun is not at the centre, but in every ninety-two thousand years it varies from extreme to less extreme. And there is also a wobble of the world's axis that shifts the seasons slowly, the precession of the equinoxes, with a rhythm of twenty-six thousand years. Together they combine in a complicated beat that gives a rhythmic fluctuation to the solar radiation reaching the polar regions of the earth. The astronomical clock ticks off millennia by the score, but does it really do much else?

It doesn't account for the ice age as a whole, for the ice came figuratively out of the blue, whereas the clock had been ticking all the time. But its peculiar rhythmic beat does seem to match the coming and going of the glacial and interglacial periods within the age. There may be a connection, though only time can tell.

Yet there is still another rhythm, which has been called the Pulse of the Earth: great periods of mountain building that seem to reach a climax every two hundred and fifty million years, with which the three or four known ice ages coincide. This may be the key to the problem, though it does bring the uncomfortable thought that we have to wait for the Rockies and the Himalayas to wear down to half their height before we see the last of our present ice-caps. In any case there doesn't seem to be much reason to believe the recession of ice now going on is more final than any of the last three extensive withdrawals. The last advance ended no more than twenty thousand years ago and maybe less, and any way you look at it that is but a small part of an interglacial period. At the very least there should be several tens of thousand years before the ice comes back, and why should we worry about it? I don't think we should, for worry will not stop it; yet the concern is there, and that is something else for wonder. The continuity of life is real, and we'd like to claim the future as well as find our past.

I must confess to a difficulty. It has seemed easy enough after a fair amount of practice to think of periods of ten or thirty million years and of the continental changes that have gone on within them. Even the million years of the Pleistocene seemed brief enough when taken by itself. But when I try to feel the periods of the ice age I struggle back to the great interglacial when the man was alive who left his skull at Swanscombe. And there I stay. I cannot cross that long, interminable interlude when the ice withdrew and we came into being. The time seems incomprehensible, never ending, like the distance to the moon when you try to see the miles of it. It comes as a definite relief to think of the first Americans, where time is post-glacial.

The unravelling of the history of man in America is fascinating. We know something of it, can guess at some more, and know nothing about much of it. And in this I think lies the intensity of our interest. It is not that early American man is more interesting than the Stone Age men of Europe. In some ways he is not. It is the excitement that comes from the present process of discovery—it is something going on now, with almost monthly bulletins—with news-flashes that make the printed page outdated before you can read it. Which is why a textbook is always so dull—the fun is all over, it is something done and its life is gone. But here is an adventure of the mind in full flight, of men employing atomic secrets to trace the greatest human journey, with subtle aids from what has long since died. And it is like a journey in itself. Columbus read his signs, read them wrong but found inspiration to go on with the voyage. Signs of our own are being read all the time, and we go forward to find new ones that say the old were false. For this is the nature of journeys and the secret of their appeal. It explains, at least in part, the scientific venture of this age, for in its less practical forms it is a journey of the human spirit into wonder, with the unknown, the unexpected, and often the beautiful found around every turn, with all decisions tentative and no last word ever said. There is no final authority, the best man is the best navigator, the one who reads the signs most accurately and knows which way to sail. What lies at the end of the journey is beside the mark.

We need to find a starting point, not so much a place and time to pick up the trail as a stage in our ideas about it. If we go back no more than twenty years we find it customary or fashionable to consider present man a product of recent times, one who emerged fully as himself only toward the very end of the last glacial phase, or even later. The discovery of the Swanscombe skull changed that, but some of the thinking that went with it still lingers on. After all, the thought that man has had a past of any kind is hardly a century old.

If we go back only ten years, or even less, we find the astronomical theory of the glacial and interglacial periods not necessarily substantiated, but certainly unchallenged. The relative durations of the different periods is of course another matter, and the thickness of various sediments laid down gives solid information concerning how long one period lasted compared with another. But the dating of them—putting the closing date at twenty to twenty-five thousand years ago, and the various other assignments that give the ice age as a whole a total of six hundred thousand years—is derived from the astronomical calendar itself. If the cosmic and planetary rhythm is responsible for the fluctuations within the ice age, the dates and durations I have used earlier are correct. The point to remember is that this particular dating of the human and Pleistocene past rests upon an assumption only, which is that, since the glacial rhythm and the astronomical rhythm have the same pattern, they must have the same actual duration and one therefore has brought about the other. It is good enough to be true, but that doesn't make it so.

We start with ideas, not certainties. And the first fact we can really get our teeth into, the discovery that gave a definite direction to thought and theory concerning the early men of North America, was the finding in 1927 of a javelin point of a very distinctive type, now known as Folsom, in unquestionable association with a species of bison now extinct. Since then there have been many more finds that show that man was in America at a time when there was a flourishing fauna of large animals which have since disappeared. You can see a photograph of the Folsom point and bison bones in Kenneth MacGowan's *Early Man in the New World*, which is, I think, by far the simplest and most fascinating account of the fossil human story from the Old World to the New.

Yet in recent years one of the most exciting discoveries, to me at least, is of an entirely different kind, and is one that throws new light on the whole picture. It is a timekeeper—a clock, if you like—which ticks off the centuries: a radioactive form of carbon-14 which is heavier than ordinary carbon and is formed from atmospheric nitrogen by cosmic rays entering the earth's envelope from outer space. There is a fixed proportion of it in the carbon dioxide that plants take up, but once incorporated in the plant tissue or wood, or in the bones of animals that eat the plants, the radioactive carbon begins to change back into nitrogen. The reversion is slow enough, goodness knows, and has hardly started within the life of the plant. But no matter how much there was to start with, half of it changes back in a little less than six thousand years. And by estimating the proportion of radioactive and ordinary carbon present in old material, whether wood or bone, we get its age if it lies anywhere between one thousand and thirty thousand years. It is an ideal tool for probing post-glacial times.

Folsom points have now been picked up over much of northern North America. The earliest sites, as tested by carbon-14, go back to about ten thousand years, but as this is well within the continental United States, a longer time is usually allowed for migration across the Bering Strait into Alaska—twelve to fifteen thousand has been suggested. It must have been close to the end of the last glacial period when the sea level was low enough for the strait to be high and dry. The first wave of immigrants are thought to have followed the coastal plain bordering on the Arctic Ocean, outflanking the mountains, as far as the Mackenzie River valley, and then to have travelled rapidly southward along the ice-free corridor that lay along the eastern side of the Rockies. With abundant game all the way from Alaska to Mexico, the Folsom migrants may have gone as far south as the game, at least to the barrier where the Mexican plateau drops to the forests of the Isthmus. It seems unlikely that they ever reached South America, but from about 8000 B.C. until 2000 B.C. the northern plains were occupied by the big-game hunters. So say most of the archæologists.

There were others besides the Folsom spear-throwing people. One of them, generally reckoned to be later, with a woodland culture and stone axes for tree-felling and adzes for woodworking, took the northern route into eastern forests. These were occupied three to four thousand years B.C. by people who depended on nuts, fishing, and hunting, and at the time were the most advanced of all Americans. The other group belonged to the plateau cultures of Arizona and points south and north, who go back at least to 5000 B.C., and who seem to have lived on seeds and small game. They are thought to have been the first immigrants into South America, but where they themselves came from is another matter.

Old trees lie prostrate here and there beneath deposits from the last glacial period. At Two Creeks Forest Bed in Wisconsin, which is very close to the southernmost limit of the last ice advance, an old forest lies shattered. The trees lie all pointing south-west and have splintered ends. You can almost hear the cracking and see them toppling as the glacier's foot creeps over them. Till recently this was thought to have been about twenty-five thousand years ago, which is what the astronomical theory says. But carbon-14 has a different verdict; it says these trees were growing eleven thousand years ago, that as recently as this the last phase of the ice age was still advancing. Perhaps the astronomical rhythms have played no part at all and we are back where we started, looking for a cause. At least we know one thing more: the great ice sheet, advancing south so recently, must have gone in a much greater hurry than we thought.

As the ice retreated, the subarctic treeless tundra along its southern margin gave place to pine, then fir and spruce, and at last to the hardwood forests. Their course can be traced, for the pollen-grains from the trees have distinctive cases and have lain preserved in the sediments of peat bogs and lake bottoms. They are microscopic but recognizable, and pine pollen lies between the bottom-most layers of sediment. Over them come layers with the pollen of spruce and fir, and above these come oak, hemlock, and a host of hardwood kinds.

Wood lies in the same post-glacial sediments, and carbon-14 has shown when it was alive. This is the sequence: the pine-belt south of the arctic tundra lay in West Virginia in 7500 B.C. By 7000 B.C. it had shifted north to Connecticut. Its line passed through South Minnesota in 6000 B.C., North Minnesota in 5000 B.C. and in 4000 B.C. it passed through Aroostock County, Maine. The same sequence has been found in Europe, and the retreat surely relates to the withdrawal of the glacial ice, and not to any dance of the planets.

When North and South America became reunited, the great ground-sloths and giant armadillos, far from being exterminated by invaders from the north, themselves invaded the northern continent. Ground-sloths reached Nevada and glyptodon armadillos at least as far as Texas. Now neither kind remains alive in either the north or the south. When did they finally disappear, and why? Man comes into the picture somewhere, though it is hard to say whether he killed off a healthy animal or pushed senility over the brink. Neither the ground-sloth nor the armadillo can be accused of speed or wit, and early men in the south seem to have taken full advantage. A pit has been found containing the four legs of the sloth in position undisturbed, but with the rest of the bones destroyed or missing, and the remains of a fire between the legs. Someone had had a banquet without troubling to take the meat home. Perhaps there were no homes, though the people knew how to trap a great beast and to light a fire.

It is even more startling to find with remains of a glyptodon not merely human implements but a human skeleton, sitting in the armadillo's armoured shell. It seems to have been an ancient form of burial—a coffin of state for what kind of man?

Part of the skin of a ground-sloth was found in a cave in southern Patagonia, dry and well preserved. It looked as though its owner had recently been alive, and legends have been recorded which suggest that the Indians saw and hunted ground-sloths not so long ago. But carbon-14 analysis applied to ground-sloth dung found in the same cave gives it an age of ten thousand eight hundred years. Human remains are not present, but in another cave not far away, burnt bone with man-chipped stones have been given an age of eight thousand six hundred years. Other ground-sloth dung, found in Gypsum Cave in Nevada, seven thousand miles to the north, is dated as ranging from eight thousand five hundred to ten thousand five hundred years old. And charcoal from human occupation sites in Nebraska, near the southern limit of the glacial push, is from nine thousand to ten thousand five hundred years old. On this evidence alone, taken together, there were men living in America, near the southern edge of the ice-cap, at a time very close to its maximum extension. And I do not believe we should think of them as Indians or even Mongols of any kind; they probably were more primitive than that—even Australoid, perhaps. Within one or two thousand years later they were certainly in the region of the Strait of Magellan, a long way south. And in contrast it is surprising, to say the least, to find the ground-sloths as far north as Nevada when the retreat of the glaciers was only beginning.

Men may have crossed the ice-free land bridge at the Bering Strait at the close of the last glacial period, as archæologists have thought for some considerable time, and these may have been the original Folsom people, with their sharp, stone-pointed spears. If they did and if they were, then they certainly were not the first, for men were settled south of the ice-cap at an earlier date than that. Either men were there who had crossed before them, or they themselves crossed at an earlier time. And the question has been raised whether the men who brought the Folsom spear-points were the ones who migrated as hunters throughout the plains. If there were people ahead of them, the technique alone perhaps diffused from north to south, for good ideas travel fast when communication exists. The record can be read more ways than one.

The men are not the only mystery. When they first arrived, whenever it may have been, many of the great mammals of the world continent were still abundant, not only the sloth and armadillo creeping up from the south, but mammoths and camels, dire wolves, and others, and above all, horses. There were horses in hordes on both northern and southern continents, the stock which has sent its emissaries to populate Eurasia and Africa.

When the Spaniards arrived, the horse was gone everywhere in the New World, yet it flourished when they brought it back, completing its trip round the world. What killed it off? Fleeter than bison, undomesticated, killed only for food by men not yet equipped with bows and arrows, they disappeared completely. The slower bison survived, and it is difficult to hold men responsible for the going of the native horse. The camels went, too, at about the same time, though reimportations have shown they can now survive in the South-west, given a little encouragement. Something in the not-too-distant past, since the coming of man, has happened on this continent that made it hard for the larger mammals to live, bison or buffalo excepted. And it wasn't the ice. All of these and others, too, had successfully survived the comings and goings of the whole ice age. The final catastrophe coincides with the arrival or presence of man, but we flatter ourselves if we consider that men were responsible.

I do not know what the answer is. It is a mystery and one that holds your interest, for there are other facts to be fitted in.

I think the giant ground-sloth gives a clue. Its bones and its footprints survive in dry Nevada—peculiarly enough, only the prints of the hind feet. You can picture a heavy, lumbering, bearlike animal plodding about on a single pair of large, flat feet. It swings its forelimbs slightly from side to side, with inturned feet and great claws ready to grub into the ground like steam shovels, of not much use for walking, but most efficient for digging up roots in rich, moist earth. This is the way it lived in the South American forests. Then what in the world was it doing in Nevada? It must have been a wetter place then than now.

Whether the Folsom technique of making spear-points spread from the north with or without its inventors, the method reached at least as far as the Sonoran Desert of southern Arizona at a time when that land supported not only horses and other plains animals but also a ground-squirrel that now lives only in open forest country and, believe it or not, a tapir that could have lived only where there was permanent water. Rivers and deep forest and three times the present rainfall were essential. Such is the picture we get from the remains found in the Ventana Cave in Arizona; there has not yet been time to apply the carbon-14 test for dates.

Yet conditions that were good for tapirs would have also suited the ground-sloths. The sloths were there nine to ten thousand years ago, as recently at least as 6500 B.C., so were men, so were horses and camels, and so probably were the tapirs. It may still seem a long time ago, but in terms of prehistory it is recent, almost within reach of recorded human time. Without any doubt the climate was different, and strikingly so.

One more piece of information falls more or less into place. Trees were killed and buried and preserved when the great volcano exploded that left Oregon's Crater Lake behind. Carbon-14 estimates of the wood date the eruption at 4500 B.C. Bark sandals from Fort Rock Cave in Oregon are dated at 7000 B.C., so that men were surely in the region when the top blew off. Was this part of the general disturbance that raised the valley floor between Death Valley and the Gulf of California and brought climatic changes as well? Time again will tell, but I like to think of it—the sea flooding far up the Colorado River, warm, humid forests along the hills, with lakes and rich grassy plains between. There must have been a swing from wet, semi-tropical conditions to an aridity even more extreme than now. When the vegetation went—

and the change was rapid—the dependent animals went with it.

The animals are one mystery, the men are another, for the earlier solution of early American man crossing the strait at the close of the last glacial period and immediately swarming across the two continents is too simple. As a recent writer has pointed out, the earliest known date for primitive man is not necessarily the earliest date. It is the earliest known date and nothing more. This is what George Carter has to say, although it is contrary to most archæological thinking of the recent past. His interest lies mainly with the ancient plateau and desert cultures of the American South-west; in particular with the presence of stone circles, possibly shelters, and certain extremely primitive stone tools. I like his argument, although I have no personal archæological experience. He finds, in brief, that the stones of the circles and the earliest tools are heavily covered with a chocolate-brown deposit known as desert varnish. What has deposited the varnish no one knows, but arrow-points of historic times have no varnish at all, while dart-points and blades of the Folsom type show a very faint varnish only. He argues then that heavily varnished stones must be very much older indeed, and men must have been present long before the Folsom came. There is much more to it than this, but it is less a matter of proving this as a fact than directing attention to a possibility, or even a probability.

The other side of the argument is that the earlier men, who are not thought to have made tailored clothes from the skins of large animals, could not have made the crossing into North America at any time while the ice-cap was in session. They could not have survived on the arctic tundra without clothing and stone lamps. If they didn't come over from Asia after the last glacial period, or during the last ice advance, they must have come before, and that places the time of the crossing at the beginning or the end of the last interglacial period, closer to one hundred thousand than ten thousand years ago. It may not be true, but Homo sapiens lived at Swanscombe twice as long ago, and he might have made the journey.

The new discoveries of cemeteries on Santa Rosa Island, off Santa Barbara, containing skeletons with red-painted skulls, of tall people who dived for red abalone and caught seals, whales, and sea-lions, suggests a coastal passage. Their discoverer dates them as flourishing eight to ten thousand years ago; carbon-14 dating has yet to come. They even took steam baths, long ahead of the Romans, and it is hard to tie them up with any hunters from over the plains.

The great civilizations of tropical America have also been given a little up-to-date treatment, and they appear younger than we had thought. The very earliest agricultural practices in Mexico, according to carbon-14, seem to have commenced as recently as 1500 B.C. Indian corn found in Bat Cave, New Mexico, is of about the same age. Agriculture started in coastal Peru, the earliest place, about 2000 B.C., but no corn was grown until 500 B.C. All of which suggests that agriculture, and the civilizations that eventually grew out of it, was invented independently, though about the same time, in different regions of America.

The carbon-14 method is ideal for dating carbonaceous materials of a certain range of age. It is not so good for more recent times, and it does not in itself give us a calendar. Yet there is a calendar that goes back for about three thousand years, which to me is as fascinating as the radioactive technique. This is the tree-ring calendar and method of dating developed by Douglass, in Arizona. At present it is a sub-science in its own right, with a name and scientific journal of its own—dendrochronology. The basic scheme is given by the giant sequoias of the High Sierras. Like all trees, a cross-section shows annual rings of slow and rapid growth, for every year of the tree's existence, in this case for as many as three thousand two hundred and fifty years. More than this, the thickness of the rings varies with the rainfall, so that we have a record of wet and dry periods for this span of time.

The tree most employed, however, is the yellow pine, for various reasons. It is not necessary to obtain the record from a single big tree, for as long as there is an extensive overlap in the times at which a succession of trees lived, a continuous record can be better made from a series of trees. Rings alone of course merely count the years, but the more or less regular narrowing and thickening of the rings has an eleven-year cycle, corresponding to the cycle of sunspots, for, however we look at it, time in the end becomes astronomical. Gradually, however, a master scale of yellow pine-tree rings has been built up, covering the greater part of the Christian era, at least for the south-western desert region.

The scale is used as a calendar against which the shorter cross-sections of pine obtained from old beams in ancient Indian dwellings and other buildings can be fitted. The series of rings in a beam made from a fifty-year-old pine will be so distinctive that a matching shows exactly when the tree lived. So we learn something about the history of the Indians during the centuries preceding the Spanish Conquest. There is little about the early Basket-makers, but the later Basket-makers, with their somewhat improved techniques, lived from A.D. 400 to 750. This is more recent than it might have been, but the really unexpected discovery is the rapidity with which the Basket-makers evolved to full public status, from A.D. 750 to about 1000. It is an astonishingly rapid advance, and suggests that the Incas and Aztecs may each have had a similarly quick rise from their primitive agricultural levels.

The great period of pueblo building and its first decline lasted for roughly three hundred years, until A.D. 1300 or slightly later, while Europe was still in the misty period of the Crusades. Then came a renewal of interest in building that was in full swing when the Spaniards arrived. And the Spaniards were in occupation of the pueblo country within fifty years of Columbus' first sailing across the bar at Saltes.

This is where we came in, where New World history recommences. In the lives of the handful of men that make this book it amounts to a span of about five hundred years—not such a long yardstick, after all. In the events which have been traced, it is time out of mind. When we come to our own time you can hear the noise of traffic in modern cities and the strident clamour of contending nations. The earth fills up and mankind is stirring everywhere. We speak of history in the making, but it has always been, and what we sense is the rush and roar of life evolving on this earth.

Journeys into wonder no longer mean travel—the greatest of them leave the physical man in his place. Yet the urge remains, and we plan trips to the moon, perhaps to Venus, and dream of travel in space. I doubt whether any man will ever have the time or the stamina for this kind of journey, for we are closer fitted to our earthly home than we yet know. Again only time will tell, but I suspect that the only real thrill for those who leave the earth will be the thrill of departure. After that it will be the choice of two evils: to land somewhere or not to land.

What is left? All that is wonderful, if we have the sense to see it. We are barely entering the world that is open to the mind and the spirit. There is confusion of thought at present because we are in the midst of an overwhelming revolution in ideas—the new has not crystallized, the old is still with us, and the mixture is unsettling. But we are probing space and plotting its galaxies, poking into atoms and dissolving matter, reaching into past time to the beginning of the earth, and looking sideways at life to see ourselves reflected. And this for no more than a few of our own generations. With time before us, there is no end, no certain goals, no knowledge of where we go, only the journey itself, rich in wonder beyond all imagination. Here at present we are like a man born blind who has been given his sight after he has long lived without it. He doesn't see what is to be seen, but only a queer assortment of colours and shapes that brings confusion. Only after months or years does real sight come, and sometimes never. This is where we are, blinking in unaccustomed light, fumbling for the meaning of what we see! There is no need to leave the earth, we just need time to grow on. God give us the time!

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